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ECONOMIC GEOGRAPHY

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Paul Cross Morrison

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THE RAILWAY TERMINAL PROBLEM OF CENTRAL CHICAGO
Harold M. Mayer

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CEMENT AND CONCRETE

CEMENT and concrete have become as vital to our industry as most of the minerals. Without them our country could not have built the great highways and dock facilities, the bridges and tunnels, that have made its transportation system so complete and expeditious, nor could it have erected the commodious warehouses, the multitude of mills and factories, the great sales and trade marts that have enabled industry to produce the adequacy of wares and equipment needed by a growing, powerful state and its people. Without them our other great resources could not have been utilized advantageously, nor could our people have achieved the standard of living which has made them the envy of the rest of the world.

So universally have cement and concrete been applied to the structural demands of our great industrial system during the preparatory stages of the present world war, that overnight, almost, great factories, great storages, great encampments have sprung up where pastures, or corn- or cotton-fields, or wooded wildernesses occupied the terrain before; and great wharves have extended themselves into the sea, and long broad highways have connected the factories with their raw materials, with the coastal ports whence our supplies, and munitions and troops were dispatched to the fighting fronts of alien shores and islands about the seven seas. Great encampments, great defenses, great hospitals have been built on the desert, in the forests, among the mountains, to serve the needs of our armed forces.

True, England and Germany and Russia have likewise turned to cement and concrete to serve their critical needs in this fast-moving war; but none of them has depended so significantly upon cement and concrete for their quick conversion from the pursuits of peace to the struggles of war, their whole system of defense and offense, as has America. To cement and concrete we owe the prompt, effective, and successful offensive that we have been able to launch so powerfully.

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CEMENT PLANT MIGRATION IN MICHIGAN

Paul Cross Morrison

THE dynamic nature of industrial geography is well illustrated in the evolution of the Michigan cement industry. Adjustments which seemed quite logical during the feverish activity attending the birth of the industry, have mostly proven rudimentary in character in the light of technological advance and mature recognition of opportunities provided by the environment of the area. As a result, significant readjustments have taken place, of which two closely interrelated ones are largely the concern of the following discussion. These are (1) the shift from marl to limestone as the principal limey raw material used in the manufacturing process, and (2) the migration of cement plants from the interior of Michigan to the Great Lakes' shores.

EARLY HISTORY

The first attempt to manufacture cement in Michigan was made in 1866 at Trowbridge Dam, on Thunder Bay River, northwest of Alpena. Argillaceous limestone was burned into a hydraulic cement, the quality of which was so variable that the effort was soon abandoned. No other known attempt was ever made in the state to commercially manufacture natural cement. By chance this first effort took place not far from the present site of Michigan's largest cement plant; one making Portland cement, however, and using limestone from a different formation.

The first Portland cement plant in Michigan, and said by some to be the first in the nation, was that of the Eagle Portland Cement Co., established some two miles northeast of Kalamazoo in 1872. Raw materials used were marl and clay, this being the first attempt in this country to use marl for this purpose. The raw material mix was air dried, cut into bricks, dried further over wood fired furnaces, and then charged in layers alternating with coke into vertical kilns of bee-hive shape. Resulting clinker was ground between millstones, potential production being about 100 barrels of cement daily. Although the product was satisfactory, costs of manufacturing by the vertical kiln method were high. The project proving financially unsuccessful, was abandoned about 1882.

Thus, cement production did not become permanently established in Michigan until 1896, when the Peerless Portland Cement Co. plant was erected at Union City.

THE EARLY BOOM PERIOD BASED ON MARL

The plant at Union City was followed by others established at Bronson

in 1897 and at Coldwater in 1898. The next few years the industry assumed boom proportions. By late 1901 some twenty-five companies had mushroomed into existence, issuing prospectusus or becoming incorporated. Practically all intended to use marl as a raw material. Proposed capitalization totaled some $25,000,000 and proposed annual productive capacity some 8,600,000 barrels. A number of the companies never reached the building stage and others started plants that were never finished. Ten factories with an annual capacity of 2,400,000 barrels were actually operating in May, 1901.

The preceding year, 1900, six plants operated, placing Michigan third among the states in cement production. Active plants were located at Union City, Bronson, Coldwater, Wyandotte, Quincy, and Mosherville (Plants 1 to 6 in Figure 2. Hereafter numbers in the text refer to plants with same numbers in Figure 2.) All, except the plant of the Michigan Alkali Co. (4), were in the south central part of the state and used marl in the manufacturing process.

FIGURE 1.—Part of a rotary kiln used for manufacturing cement. The rotary kiln may be briefly described as a steel cylinder, lined with fire brick and set at a slight inclination to horizontal. The raw material mix is automatically and continuously fed in at the upper end of the kiln, and moves down the incline by gravity as the kiln rotates. The mix is burned by fuel blown in at the lower end, from which end the resulting cement clinker discharges. This particular kiln is 179 feet long and 17 feet in diameter.

The Michigan Alkali Co. mill was established at Wyandotte in 1899 to make use of calcium carbonate sludge, a waste product resulting from the manufacture of caustic soda. Although located on the Detroit River, this plant apparently made little use of water transportation during the first few years of operation. Clay was dredged a short distance away, limestone used in the making of soda ash came by rail from Bellevue, Eaton County, and the main market for cement was in Detroit.

The boom character of the first years of the Michigan cement industry resulted from a number of factors, chief of which were probably (1) the presence of numerous marl deposits in southern Michigan, (2) the cheapening of the cost of production from marl through use of the newly developed rotary kiln and the wet process of manufacture, (3) the contemporary rapid national growth of, and interest in, the cement industry, (4) an apparently expanding market, and (5) capital eager to speculate on promising, albeit often vanishing returns.

For a time it was the general belief among Michigan producers that marl provided a more suitable raw material than limestone for cement manufacture. Most of the Michigan limestone deposits used today by cement plants were in the northern, sparsely populated part of the state and were then incompletely known. Because of this, and because of the lack of recognition of possibilities of moving the limestones by lake transportation, the deposits were considered far from market. Marl deposits, on the other hand, were common in southern Michigan.

In addition to the previously mentioned early use at Kalamazoo, marl had been successfully used by cement plants erected at South Bend, Indiana, in 1877; in New York State at Warners in 1886,

Montezuma in 1890, Jordan and Wayland in 1892; and at Sandusky, Ohio, in 1893. The influence exerted by these projects upon the use of marl in Michigan was probably important. Certainly the Michigan operators were aware of them. Because of the early methods of manufacture, it was only natural, however, that marl should be considered for use.

The first Portland cement plants in this country followed closely methods then used in Europe where, commonly, soft chalks or marls were ground with clay into a wet mixture, made into bricks, and burned in vertical kilns. The earlier of these kilns were of the "dome" or "bottle" type. They were intermittent in action, requiring fresh charging for each burning.

A rough outline of the procedure followed when using these kilns has already been given in connection with the early plant at Kalamazoo. Needless to say the process was expensive, since large amounts of hand labor were required in handling raw materials, drying and briquetting the mix, charging and drawing the kilns, and in sorting, grinding, and handling the finished product. Especially was this true in America where wages were high.

Later improved types of vertical kilns were continuous in operation, but hand labor requirements were still large. This unfavorable labor cost differential presented a major obstacle to early American producers in their efforts to overcome competition of imported European cements. A further obstacle was a prejudice, largely unfounded, in favor of certain European Portlands, especially those from Germany. In addition, since American exports were then much more bulky than imports, ocean freight rates on cement from Europe were very low or almost non-existent, cement often being carried as ballast by returning vessels. American producers had one advantage, however, in cheaper fuel supplies.

With the introduction of the rotary kiln in American mills the lower labor cost advantage of the European producers was largely eliminated, since use of this kiln made possible utilization of mechanical devices for handling both raw materials and finished product (Figure 1). Burning, for example, was performed with greater exactness than when vertical kilns were used, so hand sorting of the clinker was not necessary. Now it was possible to mechanically produce a uniform quality cement at low cost. Profiting from the greater mechanization and cheaper fuels, the American Portland cement industry entered a period of rapid expansion. This was further aided by the elimination of prejudice favoring European cement, in part a result of Government approval and use of large quantities of domestic cement during the Spanish-American War.

With the rotary kiln either the wet process or the dry process of manufacture could be used. In the wet process the raw materials are ground and mixed wet, and then fed into the kiln as a slurry. In the dry process the raw materials are handled dry, although in the earliest days a small amount of water was usually added to the mix just before charging it into the kiln, in the belief that much would otherwise be blown away.

The rotary kiln was first successfully used in American cement making at South Roundout, New York, in 1888. This was also the first use of the dry process. The first plant to use the wet process, feeding a mixture of marl and clay, without drying or briquetting, directly into rotary kilns, was located at Montezuma, New York, and started operating in 1890.

EXPLANATION FOR FIGURE 2

Names and years of operation of plants numbered are as follows: (1) Peerless Portland Cement Co., Union City, 1896–1928; Combined with the New Egyptian Portland Cement Co. in 1928 to form the Peerless-Egyptian Cement Co. The plant was abandoned soon after. (2) Bronson Portland Cement Co., Bronson, 1897–1908; First known as the Monarch Portland Cement Co., and after 1904 as the Bronson-Kalamazoo Portland Cement Co. (3) Wolverine Portland Cement Co., Coldwater, 1898—present; Before 1902 known as the Michigan Portland Cement Co., and before 1899 as the Coldwater Portland Cement Co. (4) Huron Portland Cement Co., Wyandotte, 1899—present; First known as the Michigan Alkali Co. plant, then for some years after 1903 as the Wyandotte Portland Cement Co. (5) Wolverine Portland Cement Co., Quincy, 1900—present; Before 1901 known as the Michigan Portland Cement Co. (6) Omega Portland Cement Co., Mosherville, 1900–1917. (7) Alpena Portland Cement Co., Alpena, 1901–1908. (8) Elk Rapids Portland Cement Co., Elk Rapids, 1901–1910; Reorganized in 1903 and named Elk Cement and Lime Co. (9) Newago Portland Cement Co., Newago, 1901–1931; Became a part of the Medusa Portland Cement Co. in 1929. (10) Consolidated Cement Corp., Cement City, 1901—present; Known as the Peninsular Portland Cement Co., before 1926. (11) New Egyptian Portland Cement Co., Fenton, 1902–1927; Known as Egyptian Portland Cement Co. before plant was rebuilt and management changed about 1918. Apparently did not operate after company combined with Peerless Portland Cement Co. to form Peerless-Egyptian Cement Co. (12) Aetna Portland Cement Co., Fenton, 1903–1941; Apparently known as Detroit Portland Cement Co. during organization period, and for a time at a later date as the New Aetna Portland Cement Co. (13) Great Northern Portland Cement Co., Marlborough, 1903–1907. (14) White Portland Cement Co., Chelsea, 1904–1905; Took over property and incomplete plant of the West German Portland Cement Co. (15) Burt Portland Cement Co., Bellevue, 1905–1935; Part of the Alpha Portland Cement Co. after 1920. (16) Hecla Portland Cement Co., Bay City; 1906–1910; Took over property of Hecla Portland Cement and Coal Co. (17) Huron Portland Cement Co., Alpena, 1908—present. (18) Michigan Portland Cement Co., Chelsea, 1911–1931; Built on site of earlier White Portland Cement Company. The State of Michigan acquired this plant in 1923 and operated it under name of Michigan State Cement Industry. (19) Petoskey Portland Cement Co., Petoskey, 1921–present. (20) Aetna Portland Cement Co., Bay City, 1923—present. (21) Peerless Portland Cement Co., Port Huron, 1923—present; Originally a plant of the New Egyptian Portland Cement Co. which combined with the Peerless Portland Cement Co. in 1928 to form the Peerless-Egyptian Cement Co. This name was changed to Peerless Cement Corporation in December 1929, and again to Peerless Portland Cement Co. about 1933. (22) Ford Motor Co., Dearborn, 1924—present. (23) Peerless Portland Cement Co., Detroit, 1925—present; Plant built by original Peerless Portland Cement Co. For name changes see 21 above.

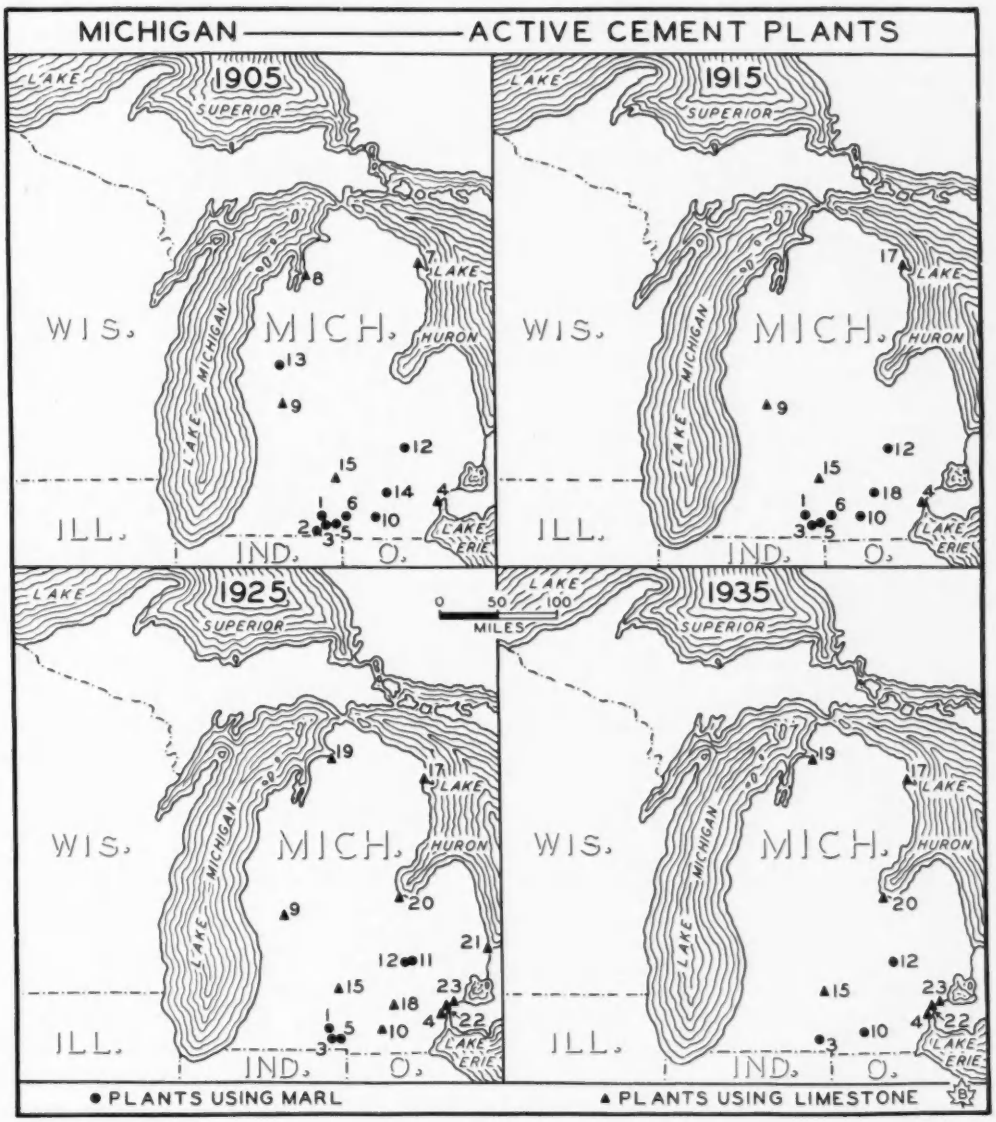

FIGURE 2.—Cement plants active during selected years. For convenience the Huron Portland Cement Co. plant at Wyandotte is shown as a limestone using plant.

Use of the rotary kiln spread rapidly. Of the six plants operating in Michigan in 1900, only the first to be established, that at Union City (1), did not use rotary kilns. This plant originally used intermittent vertical kilns, changing to continuous vertical kilns about 1900, and to rotary kilns in 1902. All subsequent Michigan plants were established with rotary kilns with the exception of a plant at Chelsea (14) which soon failed.

Since all rotary kiln plants operating in Michigan in 1900 used marl, they naturally used the wet process. Indeed arguments of those supporting marl as a more desirable raw material than limestone, for a short time seemed to have increased validity. The natural soft, wet character of marl was considered an

important advantage, it being argued that marl was as a consequence cheaper than limestone to excavate, grind, and mix into a slurry of uniform composition (Figure 3).

The uses for Portland cement during the early years of the industry were numerous and expanding, though the great use for highway construction lay years in the future. Thinking individuals, realizing that Michigan's enormous forest resources were fast approaching exhaustion, were seriously questioning what materials would take the place of wood. Cement promised to be such a material, and with its sale at low cost it found eager users. The age of cement had dawned.

Among the first users of Michigan cement were the railroads, especially for bridges and underpasses, since grade crossing elimination was already being actively agitated. The City of Detroit early adopted Portland cement construction, uses among others being the laying of street paving foundations and the substitution for tar in grouting brick pavements. The first stretches of cement pavement were laid, notably on Woodward Avenue. The Detroit United (Street) Railway began using cement in track foundations. Newer highway bridges were of cement. Miles of cement sidewalk were built. Demand for the product expanded rapidly for an ever growing list of other uses, such as foundations, basement floors, hitching posts, water troughs and tanks, tile, sewer pipe, curbs, street cross walks, fence posts, piers, docks, retaining walls, dams, concrete block, and smoke stacks.

FIGURE 3.—Showing the usual soft, wet character of lowland marl as it comes from nature. The clam shell bucket is that on the dredge shown in Figure 7. After the marl is dumped into the receiving tank, as illustrated, sufficient water is added to enable transportation to the cement plant by pipe line. Methods of transportation vary at different marl using plants, however. (Courtesy Department of Geology and Geography, Michigan State College.)

To the layman the future of the industry appeared bright, so little wonder that fraudulent or ill-advised, as well as legitimate, promotion of cement plants throve in the state. Overcapitalization was common. Stock sold widely through newspaper advertisements, at low per share prices and with promises of large dividends.

By the close of 1903 the number of marl using plants in Michigan had increased to eleven and the total number of operating plants to thirteen. In no other state was marl so generally used. Elsewhere marl was used only by four companies in New York, three in Ohio, and two in Indiana. In Michigan, nevertheless, serious doubts had already arisen as to the value of marl over limestone as a raw material. One plant was already using limestone, several were considering shifting from marl to stone, and erection of contemplated plants was being held in abeyance until it could be decided which raw material to use. This question, along with the lower cement prices of 1904, had a sobering influence. The boom soon collapsed, leaving behind a few good plants, some poor ones, and a number whose only existence had been on paper.

DEVELOPMENT OF TRENDS TOWARD USE OF LIMESTONE AND LAKE FRONT SITES

Operating experience had shown that marl deposits differed greatly in quality and usability. Some contained excessive organic matter, stones, sand, or other impurities, and were thus low in calcium carbonate. Others were sticky to handle, or contained shells or pebbly accretions which made more grinding necessary. In some cases a large amount of surfacing of overlying timber or swamp growth was required; in others, depth of water over the marl was too great. Some deposits were not thick enough to economically extract, while few single beds were of such size as to provide for many years operation of a large plant. Variation of distribution, depth, and quality of marl in a particular deposit were common.

Marls otherwise satisfactory for use, were in some cases located too far from railroads. There was a growing recognition of the possibilities of cheaply transporting cement to markets via the Great Lakes, but there was a comparative scarcity of known marl deposits directly adjacent to the shores of these lakes. Since 40 to 60 per cent of the weight of lowland marl as it comes from a deposit is water, it was necessary that cement plants be established beside the marl beds. Because of the large amounts of moisture they contained which had to be evaporated, it was found that fuel costs were higher and kiln capacity lower when marl rather than limestone was used. Also, winter operations with marl were more difficult because of freezing of the raw material.

The Alpena Portland Cement Co. plant (7), opened in April, 1901, was the first in Michigan to use limestone. It was originally intended to use marl, but when operations began, limestone was taken from a quarry beside the plant. At first manufacture was by the wet process, but in 1903 a change to the dry process was made.

This was also the first water front plant in Michigan built for the express purpose of marketing part of the product via the Great Lakes. For several years output continued near kiln capacity of about 1,000 barrels per day, probably reaching a peak in 1906 when 380,000 barrels were produced. Cement, also crushed stone, was shipped by both rail and boat. Operations ceased in 1908, as the company encountered financial difficulties.

Today the crumbling stone walls of the abandoned mill, standing on the shore of Thunder Bay, two-thirds of a mile east of the present plant of the Huron Portland Cement Co. (17), are visited only by the curious. Just to the north is the old, waterfilled limestone quarry, long the resort of naked local urchins seeking relief from summer heat.

That founders of this company were men of vision, though unfortunate in business, is attested by the success attending the later efforts of the Huron Portland Cement Co.; a success based on the same limestone deposit and cheap water transportation that the Alpena Portland Cement Co. tried to use. Today, great bulk freighters, usually of a special self-unloading type, depart from this point low in the water with loads of cement or of crushed limestone.

The next cement plant to use limestone was that of the Elk Cement and Lime Co. (8), located on Grand Traverse Bay at Elk Rapids. Built in 1901 as a wet process marl using plant, it was reconstructed about 1904 to operate using the dry process and limestone brought by rail from Petoskey.

This was the first plant in the state to shift from marl to limestone, and if

FIGURE 4.—Ruins of the Elk Cement and Lime Company plant at Elk Rapids, Antrim County. Built as a wet process plant using marl, it was later reconstructed as a dry process plant using limestone. Despite its lakeside location and the use of limestone from the same deposit as is today used by the Petoskey Portland Cement Co., the plant was abandoned in 1911.

the Michigan Alkali Co. plant (4) be excluded, the second to be located on the Great Lakes. Some 20 per cent of the annual production, which between 1905 and abandonment of the plant in 1911 ranged between 28,000 and 37,500 tons, was shipped by water, largely to Milwaukee (Figure 4). A water depth of 16 feet at the company pier permitted docking of the largest lake boats of that time.

It is noteworthy that present day lake carriers could not have docked either here or at the plant at Alpena. Also, that the first two limestone-using and lake front plants in Michigan were eventual failures. No doubt the cost of obtaining limestone by rail was a contributing cause for the failure at Elk Rapids.

The next plant to shift from marl to limestone was one established at Newago (9) in 1901. The change was made in 1905, limestone being brought by rail from Petoskey.

In September, 1905, a mill opened at Bellevue (15), using limestone from the quarry previously operated by the Michigan Alkali Co. The latter company, after disposing of this property, had in August, 1903, made the first shipment of stone to Wyandotte from a new quarry opened at Alpena. This was the first large water-side quarry, and the first to make large use of water transportation, in Michigan. The cement plant at Wyandotte (4) can after this date, if not before, be considered a lake front plant.

Thus, in 1905, fourteen cement plants operated in the state. Three of these were lake front plants and five, if the Michigan Alkali Co. plant be included, were using limestone. Marl using plants not previously mentioned had been put into operation at Cement City (10) in 1901, at Fenton (11 and 12) in 1902 and 1903, at Marlborough (13) in 1903, and at Chelsea (14) in 1904. The plant established at Fenton in 1902, the Egyptian Portland Cement Co., was idle in 1905, 1910 and 1915, among other years, so it is not shown in Figure 2 until 1925.

During the next five years 1905–1910, two lake front plants using limestone started business but one failed. Two marl plants in the interior ceased operations, one shortly after being converted for use of limestone. A third interior marl plant began production, only to fail a short time later.

At Alpena, the Alpena Portland Cement Co. (7) did not operate after 1908, but that year the Huron Portland Cement Co. (17), a subsidiary of the Michigan Alkali Co., started production. The new cement plant was erected beside the limestone quarry operated by the alkali company, to utilize stone produced that was too small for shipment to the alkali plant at Wyandotte (Figure 5). This by-product stone had previously been wasted, sold to the near-by Alpena Portland Cement Co., or shipped by boat to the Hecla Portland Cement Co. (16) at Bay City.

The latter began production in 1906 in a plant built, but apparently used only a short time, if at all, by the Hecla

Portland Cement and Coal Co. Built originally to use marl, the plant was revamped to use limestone.

The marl plant at Bronson (2) closed in 1908. At the Marlborough plant (13), extensive changes for use of limestone were made in 1906, and it is likely that limestone was used for a short period in 1907, the last year of operation. A marl plant at Bronson, the Chanute Cement and Clay Products Co., began production in 1906, but continued only a short time.

The period 1910–1915, witnessed a temporary setback in the shift to limestone and to lake front sites. The plant at Bay City (16), was abandoned sometime during this period, while the Elk Rapids plant (8) did not operate after 1910. A new marl plant (18), built on the site of the former White Portland Cement Co. at Chelsea, opened in 1911. Thus, eleven mills operated in Michigan in 1915. Seven of these used marl. Of the four using limestone, two were on the lake front.

Eleven plants also operated five years later in 1920, but the number using limestone had increased to six. Four of the latter were in the interior, two former marl plants having shifted to stone. The Cement City plant (10) began using stone about 1918, and that at Chelsea (18) in 1919. Limestone used by the Cement City plant for a time came from Lewisburgh, in southwestern Ohio. The rail rate alone on this stone was $1.26 per ton. Though subsequently reduced to $1.13, it was still excessive. Stone used later came by rail from the Sibley quarry near Detroit, or from the Alpena-Rogers City area in northern Michigan by a water-rail haul through Detroit. Stone used at Chelsea also came this route. One other marl plant, that at Mosherville (6), had closed in 1917.

Discussion of the years previous to 1920 should not be ended without mention of the development of an important new market for cement. The first concrete highway in Michigan was laid in Wayne county about 1909. By 1915 short stretches had been completed in various parts of the State but especially in the vicinity of Detroit. Although there was considerable increase in the building of concrete roads during the next few years, it was not until after 1920 that construction of this type attained really large proportions.

Legislation passed in 1919 gave great impetus to state trunk line road building, and thus to cement consumption for that purpose. During 1925, additional legislation of particular significance was passed. More recently, large Federal appropriations to the State for highway construction have been a factor of importance.

Indicative of the huge amounts of cement used is the fact that of 9,245

FIGURE 5.—A part of the Michigan Alkali Co. quarry at Alpena. The adjacent Huron Portland Cement Co. plant was established to utilize by-product "fines" from this quarry, but has grown to such size as to consume large amounts of stone in addition. Large scale, mechanical methods of production characterize the Michigan limestone industry. Though stone is mainly produced for use in the smelting of iron and steel and the manufacture of alkali, lake side cement plants have become an important market for small sized stone formerly wasted. (Courtesy Department of Geology and Geography, Michigan State College.)

miles of State highway built or under construction, June 30, 1940, almost 46 per cent, or 4,214 miles, were of concrete. Additional large quantities of cement have been consumed in building county roads (totaling 83,898 miles in 1936, of which 1.7 per cent were hard surfaced) and urban streets (totaling 13,505 miles in 1936, of which 44.6 per cent were classed as of hard or intermediate surface).

THE PEAK OF TRENDS TOWARD LIMESTONE USE AND LAKE FRONT SITES, WITH SUBSEQUENT HISTORY

During the years 1920–1925 the trends toward use of limestone and location on the lake front reached a peak. Five new plants were opened in Michigan during these years, all using limestone and all being located on the shores of the Great Lakes. Location of the new plants (19 to 23) and their first year of operation follow: Petoskey, 1921; Bay City, 1923; Port Huron, 1923; Dearborn, 1924; and Detroit, 1925. Sixteen plants were operating in 1925, plants other than the five new ones were the same as those operated in 1920.

Among the new plants, only the one at Petoskey (19) was on a limestone quarry (Figure 6). Others obtained stone by boat from northern Michigan. The plant at Dearborn (22) is of interest because it was constructed to use slag, a by-product of adjacent Ford Co. blast furnaces, along with the limestone. Likewise, the plant at Detroit (23) because it was constructed to use certain amounts of alkali waste from the near-by Solvay Process Co. plant, along with limestone and clay.

Between 1925 and 1930 few major changes occurred, except for the closing of marl plants at Union City (1) and Fenton (11). These were closed soon after the combining of the Peerless and the New Egyptian Portland Cement Companies, in January 1928, to form the Peerless-Egyptian Cement Co.

About 1930 the plant at Cement City (10) changed back from limestone to the use of marl, concluding that it was cheaper in this case to use near-by marl than limestone shipped in from a distance. Some limestone has since been used, however, though marl has remained the most important limey raw material in the mix (Figures 7 and 8).

Two limestone using plants, those at Chelsea (18) and Newago (9), did not

FIGURE 6.—The Petoskey Portland Cement Co. plant is well located on a limestone deposit sufficiently large to last 75 years at the present rate of operation, and on Lake Michigan which permits shipments of bulk cement in a special type of self-unloading boat. Worked out portion of quarry in the foreground; water of Little Traverse Bay in the background. (Courtesy Department of Geology and Geography, Michigan State College.)

FIGURE 7.—Dredge and pipeline for recovery and transportation of marl used at the Consolidated Cement Co. plant, Cement City. The marl contains 90 per cent calcium carbonate and is taken from the lake without previous surfacing operations. Reserves are said to be sufficient for 15 years of plant operation. The pipeline to the cement plant is three miles long. (Courtesy Department of Geology and Geography, Michigan State College.)

operate after 1931. Both were in the interior of the state. A basic reason for their closing was the high cost of shipping in limestone from a distance by rail. They were at a disadvantage in competition with the newer lake front plants, however, not only in regard to cheaply obtaining limestone, but in reaching markets as well.

Rail rates on limestone from Petoskey to Newago are reported to have been as high as $1.30 per ton at one time, but were later reduced to 90 cents per ton. The plant at Chelsea was operated by the State of Michigan subsequent to 1923. Convict labor was used, but operation was generally at a loss. While this was no doubt, in part the result of inefficient public management and politics, as charged by some, and of obsolete equipment, another important reason was the cost of $1.20 per short ton for limestone delivered at the plant. Rail freight charges from the Detroit area, to which the stone was delivered from Rogers City by boat, amounted to 60 cents per ton. Approximately this freight charge then, was an added cost over what cement plants located on the water front at Detroit paid. Just before cessation of operations, it was costing the State about $1.40 to produce a barrel of cement. At the same time, private companies were selling it for as low as 60 cents per barrel.

Of the other plants which operated in 1930, the limestone-using plant at Port Huron (21) was idle between 1932 and 1937, and the marl plant at Quincy (5) between 1931 and 1936. Thus ten plants operated in 1935, three on marl and seven on limestone. Six were lake front plants.

In 1940 nine plants produced. Plants at Port Huron (21) and Fenton (12) were idle. After a short period of operation in 1937, the Port Huron plant remained idle, though maintained in operating condition, until 1941. Since June, 1943, this plant, like several in the Great Lakes area, has been manufacturing lime, but can be shifted back to cement production on short notice. The plant at Fenton was idle between 1936 and 1941. It was reopened in 1941, but has since been dismantled. Thus another marl plant passed out of existence. The limestone plant at Bellevue (15) did not operate after 1935.

A summary of the above discussed changes during each five year period between 1900 and 1940, is given in Table I.

As previously indicated, the wet process of manufacture was used in early Michigan cement plants operating on marl. It soon became evident, however,

TABLE I

MICHIGAN CEMENT PLANTS—NUMBER, RAW MATERIAL, SITE
SELECTED YEARS

Year	Number of Active Plants	Using Marl	Using Limestone	In Interior	On Lake Shore	Plants Established This and Four Preceding Years		Shifts from Marl to Limestone This and Four Preceding Years	Plants Abandoned Five Preceding Years		Idle Plants
						Marl	Limestone		Marl	Limestone	
1900	6	5	1*	5	1	5	1	..	..	..	..
1905	14	9	5*	11	3	7	2	2	..	..	1‡
1910	12	6	6*	8	4	2	1	2	3	2	1‡
1915	11	7	4*	9	2	1	..	..	..	2	1‡
1920	11	5	6*	9	2	..	..	2†	1	..	..
1925	16	5	11*	9	7	..	5	..	..	..	..
1930	14	4	10*	8	6	..	..	..	2	..	..
1935	10	3	7*	4	6	..	..	..	..	2	2**
1940	9	3	6*	3	6	..	..	..	..	1	2**

*The Wyandotte plant of the Huron Portland Cement Company is included as a limestone using plant because it is not known how much limestone, if any, has been used in addition to alkali waste. Figure for 1925 may include one or two plants which used both marl and limestone.

†One plant later shifted back to marl.

‡Interior, marl using plant.

**One plant an interior, marl using plant, and the other a lakeside, limestone using plant.

that with equipment and methods then available, the wet process plant using marl was generally not as economical as the dry process plant using limestone. For some years thereafter, the dry process plant gained in relative importance as marl plants shifted to limestone and several new limestone-using plants were established.

By 1920, however, improvements in equipment and technique used with the wet process had been such as to greatly reduce fuel costs. Thus a major objection to the process was eliminated, giving greater weight to arguments favoring its use. Chief of these were that the wet process permitted more economical and finer raw material grinding, more accurate control of the raw mix, better burning conditions and a more uniform product, than did the dry process. As a consequence, all Michigan cement plants established after 1920 were wet process plants.

Among other improvements, the general installation in the late twenties of slurry filters for mechanical extraction of moisture from slurry before charging it into the kiln, still further reduced fuel requirements of the wet process. The larger manufacture of high early strength cements, which require very fine grinding and accurate raw mixture control, served also to increase the wet process in favor. Today only the plant at Alpena does not use this process.

Considering the above, it is apparent that the establishment of five limestone-using plants in Michigan between 1920 and 1925 occurred after one of the more important original reasons for the shift from marl to limestone had been largely removed. By this time, however, the advantages of a lake front location were fully recognized.

The high calcium limestone deposits of Michigan suitable for cement making are almost entirely in the northern part of the state. But since these deposits are on the shores of the Great Lakes, and because of the very low cost of transporting stone by water, any lake front cement plant is in effect near this source of limestone supply. Cost of limestone is low as a result of large scale, mechanized quarrying, use of "fines" which were formerly a quarry waste, and transportation in self-unloading boats

of special design. This has permitted some plants, as at Detroit, to locate on the edge of large markets which can as a consequence be served by motor truck delivery of cement.

Because of the possibility of cheaply transporting bulk or packaged cement long distances by water, the potential market area in which lake front plants can compete is also greatly enlarged. As might be expected, however, the Michigan water front plants moving the greatest amounts of cement on the Lakes are those at Alpena (17) and Petoskey (19). Both are beside limestone quarries in the northern part of Michigan's southern peninsula. Their local markets are as a result somewhat limited, but they have been able to efficiently serve more distant lakeside markets through their development and use of self-unloading, bulk cement carrying freighters, and the establishment of storage silos and bagging plants at important lake ports.

The abandonment of most of the Michigan plants using marl has been due to shortages of suitable raw materials, the cost of transporting marl from greater and greater distances as near-by deposits were exhausted, low plant output, plant obsolescence, and freight rate disadvantages in competition with lake front plants for large areas of market.

FIGURE 8.—Clay used by the Consolidated Cement Co. plant, Cement City, comes from a pit at Rollin, about ten miles to the south. Clay or shale used by Michigan cement plants now comes from near-by deposits, though in the early days some plants obtained clay from northwestern Ohio.

Michigan cement plants using limestone before 1920, except those at Wyandotte (4), Bellevue (15), and Alpena (17), were originally located so as to operate on marl. Most of them were in the southern interior part of the state where suitable limestone deposits were absent. Because of interior position, they also, like the marl using plants, found difficulty in competing with lake front plants in many markets.

The extent to which interior plants were abandoned after their owners built new facilities on the lake front, or after being absorbed by a company with a lake front plant, is interesting and significant. Plants at Fenton (11) and Union City (1) were abandoned after their owners had established new operations at Port Huron (21) and Detroit (23), and had combined to form what is today the Peerless Portland Cement Co. The Aetna Portland Cement Co., with a newer plant at Bay City (20), has recently dismantled its plant at Fenton (12). The plant at Newago (9) ceased operation soon after a merger of it and the Manitowoc Portland Cement Co., Manitowoc, Wisconsin, with the Medusa Portland Cement Co. Before the merger took place, however, the Newago company had acquired lake front limestone property at Charlevoix, Michigan, and had done preparatory work to establishing a plant there. After the merger, and because of the depression, this project was dropped. The company already had a lake front plant, the one at Manitowoc.

Those companies owning interior plants who later built new ones on the lake front, no doubt did so, in part at least, as a means of self-preservation. Their decision to build on the water

front was implemented by the recognition of competitive advantages of such a site, the greatly increased demand for cement during the early twenties, the rapidity of plant equipment obsolescence, and the realization that if they did not establish lake side plants, newly formed companies would, as indeed a number did.

As is true today, so rapid had been improvements in cement making machinery and methods that equipment became obsolete in a few years and while yet in good operating condition. Thus the decision was in part one of using money to modernize the old plant, or to add more and establish an up-to-date plant on the Great Lakes. Creation of much new productive capacity on the lake shore during the period 1920–1925, naturally resulted in abandonment of older, less efficient and poorer located interior plants, both those using limestone and those using marl. This adjustment was hastened by the depression years of the thirties, and may not yet be ended.

The three marl using plants (3, 5, 10) presently operating have apparently been able to continue because of ability to obtain sufficient supplies of suitable marl at not too great a distance, efficiency of management, continuous plant equipment modernization and innovation, and favorable connection by rail and highway to the interior markets of southern Michigan and nearer parts of adjacent states. The position of the remaining plants in these markets was doubtless strengthened by the closing of the other early interior plants.

(For further discussion of the production and shipping of Michigan limestone, the importance of this limestone to cement plants, and the position of Michigan lake front cement plants in the cement industry and trade on the Great Lakes, the reader is referred to three papers previously published in ECONOMIC GEOGRAPHY—"The Michigan Limestone Industry," Vol. 18, No. 3 (1942), pp. 259–274, "Michigan Limestone in the Great Lakes Stone Trade," Vol. 18, No. 4 (1942), pp. 413–427; "Cement Production and Trade on the Great Lakes," Vol. 20, No. 1 (1944), pp. 37–53.)

STATISTICAL SUMMARY

From the selected statistics given in Table II it is evident that Michigan is one of the more important states in cement production. During recent years, only Pennsylvania and California have commonly had a larger output.

Production in Michigan has had two periods of major growth. The first was during the early boom period of the industry, production increasing from 4,000 barrels in 1896 to 3,747,525 barrels in 1906. The second was during the years 1921 to 1927, years for the most part of much building, widespread industrial expansion and business prosperity. The early twenties were also a period of expanding cement plant productive capacity. This was the period during which the major shift of Michigan cement plants to limestone and to lake front sites took place. Peak production of 13,965,241 barrels was reached in 1927; peak estimated plant capacity in 1928.

Output during the depression years of the thirties reached a low of 3,632,834 barrels in 1933, less cement than was manufactured in 1906 when the automobile was still in the experimental stage and rural concrete highways were scarcely dreamed of. Estimated plant capacity utilized in 1933 was 19.1 per cent, no doubt a record low for this figure. Likewise, the estimated per capita consumption of about one-half barrel during this year was the lowest for many years.

TABLE II

MICHIGAN CEMENT INDUSTRY—SELECTED STATISTICS[1]

(Barrels unless otherwise indicated)

Year	Active Plants	Average Factory Price	Production	Position Among States	Per Cent Total U.S. Production	Estimated Consumption	Shipments from Plants	Shipments Surplus (+) or Deficiency (−)	Estimated Consumption Per Capita	Estimated Plant Capacity	Per Cent Capacity Used
1896	1	$1.75	4000	9	0.26	.....	.....	.....	....	.....	....
1897	2	1.75	15000	7	0.56	.....	.....	.....	....	.....	....
1898	2	1.75	77000	?	2.08	.....	.....	.....	....	.....	....
1899	4	1.49	342566	5	6.06	.....	.....	.....	....	.....	....
1900	6	1.25	664750	3	7.84	.....	.....	.....	....	.....	....
1901	10	1.10	1025718	3	8.07	.....	.....	.....	....	.....	....
1902	10	1.35	1577006	3	9.15	.....	.....	.....	....	.....	....
1903	13	1.37	1955183	3	8.75	.....	.....	.....	....	.....	....
1904	16	1.05	2247160	3	8.48	.....	.....	.....	....	.....	....
1905	16*	1.05	2773283	4	7.87	.....	.....	.....	....	.....	....
1906	14	1.28	3747525	4	8.06	.....	.....	.....	....	.....	....
1907	14	1.23	3572668	4	7.32	.....	.....	.....	....	.....	....
1908	15	.88	2892576	7	5.66	.....	.....	.....	....	.....	....
1909	12	.81	3212751	7	4.94	.....	.....	.....	....	.....	....
1910	12	.92	3687719	8	4.82	.....	.....	.....	....	.....	....
1911	11	.82	3686716	8	4.69	.....	.....	.....	....	.....	....
1912	11	.86	3494621	8	4.24	.....	.....	.....	....	.....	....
1913	11	1.04	4186236	8	4.54	.....	.....	.....	....	.....	....
1914	11	.96	4285345	7	4.86	3664149	4218429	+ 554280	1.24	.....	....
1915	11	.94	4765294	5	5.55	3950532	4727768	+ 777236	1.31	.....	....
1916	11	1.17	4919023	6	5.37	4820946	5151818	+ 330872	1.58	.....	....
1917	11	1.42	4688899	6	5.05	4425533	4313771	− 111762	1.43	.....	....
1918	10	1.68	3554872	8	5.00	3266393	3618088	+ 351695	1.04	.....	....
1919	11	1.70	4675244	4	5.79	5097575	4990308	− 107262	1.39	.....	....
1920	11	2.46	4891457	7	4.89	5142945	4442455	− 700490	1.37	7011000	69.8
1921	11	1.81	5777533	3	5.84	6112986	5680156	− 432830	1.59	8006000	72.2
1922	12	1.76	6243805	4	5.44	6196586	6349751	+ 153165	1.58	7930000	78.7
1923	14	1.88	7619792	3	5.54	7531664	7466283	− 65381	1.87	9346000	81.5
1924	15	1.82	9259781	3	6.20	9355024	8991270	− 363754	2.28	11501000	80.5
1925	16	1.74	10936181	3	6.76	9564976	10073453	+ 508477	2.31	15301000	71.5
1926	16	1.63	12037400	3	7.32	10784049	11959447	+1175398	2.45	?	?
1927	15	1.52	13965241	3	8.06	11576188	13708259	+2132071	2.58	18591000	75.1
1928	14	1.37	13848561	2	7.85	11776282	14044230	+2267948	2.57	19508000	71.0
1929	14	1.42	13748862	2	8.06	11686635	13325727	+1639092	2.55	18535000	74.2
1930	14	1.38	11510895	2	7.14	8625691	10817994	+2192303	1.78	19241000	59.8
1931	14	.97	6132768	6	4.89	5582116	7168720	+1586604	1.13	19235000	31.9
1932	13	.91	4295610	5	5.60	3476002	4886928	+1410926	.70	19145000	22.4
1933	10	1.20	3632843	6	5.72	2465262	3447867	+ 982605	.49	19044000	19.1
1934	10	1.50	4103902	5	5.28	2966829	3945375	+ 978546	.58	17180000	23.9
1935	10	1.38	4578966	3	5.97	3324864	4325134	+1000270	.71	17080000	26.8
1936	10	1.32	7673324	3	6.81	5657317	7960821	+2303504	1.18	16480000	46.6
1937	11	1.26	8180969	3	7.04	5359971	7831880	+2471909	1.11	16605000	49.3
1938	11	1.22	7159362	3	6.79	5288904	7192511	+1903607	1.10	16605000	43.1
1939	9	1.31	8218760	3	6.72	5338188	8327479	+2989361	1.11	16605000	49.5
1940	9	1.34	8603188	3	6.60	5760481	8519416	+2758935	1.10	15196000	56.6

[1]Compiled from *Minerals Yearbook*, U. S. Bur. of Mines.
*The writer was able to account for only 14 active plants in 1905.

Production during 1940, the last year of available record, amounted to 8,603,188 barrels. While still considerably below the peak of 1927, this was the largest for any year after 1930. It is notable that fewer plants operated in 1939 and 1940 than during any year subsequent to 1900. Total plant capacity was larger than that for any year before 1925, however, being indicative of the large size of several of the lake front plants.

Regarding average factory prices, the most significant fact is that prices during recent years are in general as low as during the early years of the industry, and this despite greatly increased wage rates, taxes, and certain other items of expense. Greater mechanization and improved efficiency in all steps

from raw material quarry to consumer have served to keep cement prices down.

Of statistics given in Table II, however, those concerning the surplus or deficiency of shipments from Michigan cement plants in relation to Michigan consumption are of particular portent in connection with this paper.

Previous to 1925, Michigan consumption exceeded Michigan cement shipments during many of the years for which records are available. That is to say, cement from other states was marketed in Michigan in considerable net amounts during these years. As long as Michigan cement plants were largely located in the interior of the state, rail rates and competition from extra-state cement largely confined Michigan cement to local markets.

Since 1925, however, shipments from Michigan plants have exceeded consumption in the state by approximately 1,000,000 to 3,000,000 barrels annually. These excesses represent the net amounts of Michigan cement sold in markets outside of the state.

Most cement leaving Michigan goes by water. True, considerable amounts are shipped out by truck, rail, or by rail and car ferry, but these amounts are largely balanced, or more than balanced, by shipments into the state via the same agencies. Shipments from Michigan by lake boat in 1938, for example, were in the neighborhood of 375,000 short tons, a larger figure than the estimated 357,878 tons (1,903,607 barrels) surplus of state shipments over consumption.

Thus, the development of the related trends in the Michigan cement industry towards use of limestone and location upon the lake shore, has not only exerted a large influence upon the growth of Michigan limestone quarrying and the Great Lakes stone trade, but has made possible efficient servicing and capture by Michigan cement plants of a larger share of the market for cement, not only in Michigan, but also in the other states bordering the Great Lakes.

WATER SUPPLY OF THE INCORPORATED TOWNS AND VILLAGES WITHOUT ORGANIZED SYSTEMS

J. R. Schwendeman

AMONG characteristic projections on the horizon over the plain of the Red River basin is the grain elevator. These grain elevators mark villages which collect and ship every type of agricultural product of the basin. In most instances they also serve as trading centers for much of the merchandise for farmers. In spite of improvement in roads and the convenience and speed of trucks, this merchandising service has not been concentrated to any great extent. This is due to the increase in costs with longer hauls of farm produce to the larger centers. Clustered about this elevator and shipping point are homes of the villagers who need to carry on this service. Although most of these villages have been reduced in population, they still persist, distributed widely and uniformly over the basin, and will very likely continue to be part of the cultural landscape of the basin (Figure 1, plates A, B, C, and D).

These villages represent an interesting element in the water supply and use in the Red River basin. There are 151 of these villages which have incorporated, but which do not have an organized water system representing about 20 per cent of the incorporated population. There are, in addition, undoubtedly a large number of villages which still retain their affiliation with the township administration.

The questionnaire on the following page was sent to practically all of these villages with a population of 300 and a few with populations under 300. The questionnaires were returned by 60 villages, or, about 40 per cent of the total incorporated places outside the organized systems. These 60 villages have 20,835 people, or, about 48 per cent of this population group. They report almost every conceivable source of water supply and a wide variety of equipment for supplying water.

The Source of Water Supply for Unorganized Village Systems

Sources of water for the villages are well, cistern supplemented by snow, ice, stream, spring, slough, and lake. Forty-seven villages report wells as a source of supply and 36 add cisterns as an additional source of supply. None depend upon cisterns alone but always list the cistern with some other more reliable source. Twenty-three report the use of snow and ice as an additional source of water and never wholly depended upon, although some places report ice shipped in during the summer and some report private ice houses for preserving ice during the summer and using it both for refrigeration and water.

Snow cover usually begins early in November and remains more or less until approximately mid-March, and ice is available from rivers, lakes, and sloughs during this same period. Of the balance of the villages reporting, seven report spring supply wholly or in part; seven, river water for partial supply, and one lake and one slough are reported for some supply.

VILLAGE WATER SUPPLY SURVEY OF THE RED RIVER BASIN OF THE NORTH
By—Geography Department
State Teachers College, Moorhead, Minnesota

1. Name of Village.....1940 population.....
   Location in Township.....County.....
2. Check the source or sources of water supply: Well....., Cistern.....,
   Spring....., Stream....., Other.....
3. How are the homes equipped for water supply: Cistern pump in house.....
   Cistern pump outside.....Well water piped in house.....
   Other supply.....Is any water carried to the house.....
4. How is the town supplied with drinking water: Public well....., Private wells.....,
   Any other public supply.....
   .....
5. If the cistern supply is exhausted during drought or in winter, how is it replenished: By hauling
   well, spring, or other water supply.....from what place
   and what distance.....
   Is snow or ice melted and used in winter.....
6. What is the prevailing well depth in the town.....
   Depth of the shallowest well.....Deepest well.....
   Do any of the wells reach bed rock.....What formation.....
   .....
7. What are the most pressing water supply problems.....
   .....
8. If possible give the approximate number of wells within the village corporation limits.....

VILLAGE EQUIPMENT FOR SUPPLYING WATER

Water pails must be common in the villages for 34 villages report carrying water into homes from some outside supply as more or less regular. Water tanks for hauling are next in evidence for transporting water; 23 villages report hauling water from some source near the village. The number with pumps in their houses for pumping water from well or cistern was not tabulated but reported 38 instances as more or less used in each village. Some pumps were reported on the premises and outside the houses. Also several reported some kind of party line pressure systems, several have individual pressure systems, and usually there is a pressure system for the school with sewage disposal. Just how the snow and ice are melted for use is not revealed by the report (Table 1).

INDIVIDUAL VILLAGE REPORTS ON WATER SUPPLY AND USE

Minnesota Villages:

Alvardo, Marshall County, reports four artesian wells of only 16 feet in depth. No bedrock is in evidence. They have plenty of pure water, and the school and creamery dispose of sewage into the Snake River.

Audubon, Becker County, depends wholly on a spring for supply with sufficient pure water for present purposes but little for future expansion. They report that they have no central type of sewage disposal.

Calloway, Becker County, reports three wells within the corporation limits at an average depth of 110 feet.

Clearbrook, Clearwater County, has plenty of good water from a 52 foot artesian well with water system for a school of 300 students including showers.

Climax, Polk County, reports the

TABLE I

VILLAGE UNORGANIZED WATER SUPPLY REPORTS

MINNESOTA

Village	*County*	*Population 1940*	*Source of Supply*	*Use of Water, Water Problems and Other Information*
		500 or over population		
Karlstad	Kittson	501	Well, snow, and ice	Individual sand points
		300 to 500 population		
Audubon	Becker	312	Spring and cistern	Carry and haul
Alverado	Marshall	336	Artesian well	.....
Clearbrook	Clearwater	425	Artesian well	School has own system
Gary	Norman	300	Well, cistern	Carry
Glyndon	Clay	405	Well, cistern	Carry and haul
Gonvick	Clearwater	317	Well, cistern, snow and ice	Carry and haul
Lancaster	Kittson	473	Well, cistern, snow and ice and river	Carry and haul
Newfolden	Marshall	300	No city system	.....
Oslo	Marshall	392	Well, cistern, snow and ice	Carry and haul
Plummer	Red Lake	312	Well, cistern, snow and ice	Carry
St. Vincent	Kittson	327	Well, cistern, spring, ice	Carry and haul
Vergas	Otter Tail	351	Well, cistern, snow and ice	Carry and haul
Waubun	Mahnomen	438	Well	Some private systems
		Under 300 population		
Calloway	Becker	249	Well	.....
Climax	Polk	253	Well, cistern	Carry
Goodridge	Pennington	174	Well	Carry
Hitterdal	Clay	268	Well, cistern, lake	Carry and haul
Mentor	Polk	287	Well	Carry
St. Hilaire	Pennington	288	Well, cistern, river, snow and ice	Carry and haul
Shevlin	Clearwater	226	Well, cistern, snow and ice	Carry
Wendel	Grant	273	Well	Some village organized system
		SOUTH DAKOTA		
New Effington	Roberts	344	Well, cistern	Cisterns in houses, and well water carried. Plenty of water, outside toilets
Rosholt	Roberts	362	Cistern and deep well	Water carried, cisterns in houses
		NORTH DAKOTA		
		500 and over population		
Aneta	Nelson	509	Well, cistern	Carry
Drayton	Pembina	688	Well, cistern, stream, snow and ice	Carry and haul
Milnor	Sargent	677	Artesian well	Party line using Artesian pressure
Maddock	Benson	691	Reservoir	.....
Minto	Walsh	630	Cistern, well, ice	Ice shipped for water
Portland	Traill	551	Well, cistern, spring, snow and ice	Carry and haul
St. Thomas	Pembina	503	Well, cistern	Artesian well for fire
		300 to 500 population		
Arthur	Cass	335	Well, cistern	Carry
Bathgate	Pembina	312	Well, cistern, river ice for drinking water	.....
Buxton	Traill	404	Well, cistern	Carry and haul
Cogswell	Sargent	430	Artesian well	City piped but no rate
Crystal	Pembina	428	Well, cistern, spring, snow and ice	Carry and haul
Esmond	Benson	449	Well, snow and ice	Carry
Fingal	Barnes	300	Well, cistern, stream, slough, snow and ice	Carry and haul
Fordville	Walsh	439	Well	Carry water. Private pressure in several homes and in school

TABLE I—*Continued*

VILLAGE UNORGANIZED WATER SUPPLY REPORTS

NORTH DAKOTA

Village	*County*	*Population 1940*	*Source of Supply*	*Use of Water, Water Problems and Other Information*
			300 to 500 population	
Hannaford	Griggs	405	Well, cistern, spring and stream	Carry and haul
Hoople	Walsh	346	Well, cistern, spring	Haul
Hope	Steele	474	No water system	.....
Hunter	Cass	414	Well, spring, snow and ice	Carry and haul
Kindred	Cass	450	Well, cistern, snow and ice and from farmers	Carry and haul
Litchville	Barnes	430	Artesian wells, some cisterns	Carry (artesian well furnishes some water to homes by own pressure—fire protection by pump)
Milton	Cavalier	310	Well, cistern, snow and ice and reservoir	Carry and haul (few individual pressure systems)
Michigan City	Nelson	491	Well, cistern	Carry
Page	Cass	428	Well, cistern, snow	Carry and haul
Sandborn	Barnes	366	Well, cistern, snow and ice, spring, river	Carry and haul
Sarles	Cavalier	302	Well, cistern, snow and ice	Carry and haul
Sharon	Steele	371	Well, spring	Haul
Tower City	Cass	364	Well, cistern, snow and ice	Carry and haul
Sheyenne	Eddy	431	Well, cistern, river	Carry and haul
Totals	53 reports	[c]20,841	49 wells 36 cisterns 23 snow and ice 7 river 9 springs 1 lake 1 slough	39 carry or haul or both
Percentage		[c]20.3% of corporate population have no organized systems [c]46.8% of the unorganized systems have reported		

prevailing well depth at 225 feet with ten wells within the corporation limits. The deepest well is given at 280 feet.

Gary, Norman County, reports 100 wells within the corporation limits at from six to eight feet to 281 feet in depth. Well water is piped to homes and they state no pressing problems in supply.

Glyndon, Clay County, reports water carried in most cases—some water is hauled from nearby villages. The prevailing well depth is given at 125 feet with lowering of the water tables in recent years. In an interview with Superintendent of schools, James Dahl, the writer was given a student survey of the community wells giving depth and water levels, made under Mr. Dahl's supervision. The number of wells within the town limits was given at ten. The teacherage and school is supplied with a pressure system. While the writer was at the teacherage several townspeople came in with pails and filled them with water at the sink.

Goodridge, Pennington County, reports all water carried to homes from a public well and states their most pressing need is fire protection. Well depth is given at 65 feet.

Gonvick, Clearwater County, states that when the home supply of cistern water gives out during drought or in winter the supply is replenished by hauling softened water from the creamery. Snow and ice is melted to some extent. The town reports 18 to 20 wells at from 140 to 300 feet deep but they state that they do not know if bed rock is reached by these wells. The school has its own well.

Hitterdal, Clay County, has about ten wells within the town limits, both

public and private, ranging in depth from 40 to 50 feet most commonly, but with one well at 160 feet deep. No bed rock is reported. Most of the water is carried to the homes and some water is hauled from lakes four to five miles distant. They state as their most pressing problem, "To get sufficient pure drinking water."

Karlstad, Kittson County, reports no city system and for a city of 501 population this is not common in Minnesota. Only five others of the 500–1000 class on the Minnesota side of the basin do not report an organized system. Their water supply situation is unusual and probably explains their failure to provide an organized system. The people of Karlstad have individual sandpoints inside homes and out, and with water thus so easily available, the organization of a common system has been excluded. They report 150 wells on sandpoints alone and state that the only supplementary source is the melting of ice and snow for soft water. The prevailing well depth is 18 feet, however, the deepest well is reported at 150 feet. Of their locality the report says, "We are located on a ridge which seems to have a basin shaped water hard pan of clay. This has never given out yet. Many individual pumps and sceptic tanks have been installed. I would judge that there are 20 such systems in the village."

Lancaster, Kittson County, says that most of their water is carried into their homes although they report some water from both cisterns in their homes and well water piped into homes. Water is also reported hauled from the north branch of Two Rivers. Snow and ice are melted to supplement their supply. Wells are shallow at from 18 to 35 feet with no bedrock reported. They report 35 wells in the town limits but state that their most pressing problem is a water supply system.

Mentor, Polk County, has both public and private wells and replies that water is carried to their homes. They have 10 to 12 wells in town at 25 to 93 feet deep, but they also list organization of the water supply as their need.

Newfolden, Marshall County, reports an artesian well but no city system.

Oslo, Marshall County, says that drinking water is carried to most homes and that some water is hauled by truck from Warren, Minnesota and Inkster, North Dakota. Warren is 16 miles from Oslo. Ice and snow are melted for supplementary supply. As their most pressing problem they say, "Our wells are all surface wells and the water supply is too limited. In dry periods the wells are pumped dry many times a day." Further, as to number of wells they answer—"Three city wells and one private well from which drinking water is obtained. There are two or three private wells, but the water from these wells is not used for drinking purposes." They report the deepest well at 20 feet and add, "Deep wells in most cases result in salt water in this area."

Plummer, Red Lake County, puts wells, cisterns, and snow and ice as sources of supply. They have a public well, new this year, but add that the water is soft and does not have a good taste. Wells are numbered at 30 for the town and the depth is from 35 to 235 feet.

Saint Hilaire, Pennington County, reports water carried to the homes and hauled from the Red Lake River. Snow and ice are melted. Twelve is the number of town wells given with 140 feet as the prevailing depth. No bedrock is reported and they list as a problem, silt coming up in the water in small amount.

Saint Vincent, Kittson County, replies

that water is carried to the homes from the wells in the village and list a public well. Water is hauled from the village well and from springs at Kennedy, 30 miles distant. Ice is taken from the Red River and melted. Only two wells are reported in town at 12 and 18 feet in depth. As to their most pressing problem they answer, "Artesian wells are salty, surface wells, as used, dry out in drought. Water problem is great."

Shevlin, Clearwater County, states that they have 50 wells within the city limits in depth ranging from 25 to 50 feet with 35 feet the prevailing depth. Water is carried and snow and ice melted.

Vergas, Otter Tail County, has water carried to homes and hauled from Long Lake one-half mile distant, with snow and ice reported quite commonly melted for water supply. They have 15 wells at an average of about 74 feet deep but a maximum of 200 feet in depth. Their most pressing problem is obtaining good drinking water and the financing of water projects.

Waubun, Mahnomen County, places the number of wells in town at 100 and add that they have no water problems and that ten per cent of the homes have private water systems. Wells are 16 to 65 feet deep.

Wendell, Grant County, states that they have just the one village well at 265 feet deep and that they have a water main with 8-inch, 6-inch and 4-inch copper service to most of the houses.

North Dakota Villages:

Aneta, Nelson County, reports water to be carried to a great extent and some is hauled from the city well. Forty wells are listed in the city at from 25 to 250 feet and bedrock is reached. No pressing problems are reported and no snow and ice are used.

Arthur, Cass County, gives the information that they have wells and that cisterns, both, inside and outside the homes, are part of their water supply. They report that most of the water, however, is carried to the homes and that the city supplies water by hauling from the city well to replenish deficiencies in the home. Their most pressing problem is impure water and the hauling of water because of distance. There are three wells in the city and about six families have water piped from these wells.

Bathgate, Pembina County, reports ice used for drinking water during winter with probability of shipping it in during the summer. The river supplies all other uses.

Buxton, Traill County, reports a public well controlled by the City Board. Water is hauled in by draymen in possession of a key to the well house. The source is reported from a moraine one-half mile west of the village.

Crystal, Pembina County, says that most drinking water is carried to the homes and that water is hauled from a spring, eight to ten miles distant. Snow and ice is melted for other uses than drinking. Ten or 12 wells are listed in the city limits at approximately 20 feet deep with no bedrock. They report that during the past few years, wells have become exhausted especially in the fall season.

Drayton, Pembina County, replies that they use water from well, cistern, stream, and snow and ice. Water is carried to homes in most cases and also hauled from the Red River which flows by the city. Wells are shallow at 14 to 18 feet; 12 are located in the town. Private wells are reported going dry.

Fingal, Barnes County, reports both a public and private well and some cisterns. Snow and ice are melted for supply and water is hauled two miles

from sloughs and ditches. The common well depth is 14 feet varying from ten to 20 feet. There are 38 wells in town which are reported dry during recent drought years. The Soo Railway has a large well for its supply here and the town has three fire wells.

Fordville, Walsh County, says that carrying water to the homes is the common practice; that the prevailing well depth is 35 feet with no bedrock observed and that several homes and the school have their own pressure systems. No snow or ice is used.

Hannaford, Griggs County, reports most of the water is carried, that there is no public supply; and individuals get water from wells, cisterns, spring, and stream. Water is hauled from streams and from the Great Northern railway depot at the edge of town. Fifteen wells are in town with prevailing depth at 30 to 40 feet but one is given at 500 feet deep. Their problem is that water is not piped to their homes.

Hoople, Walsh County, lists cisterns to catch rain water; a few surface wells, spring water which is hauled in and placed in cisterns.

Hunter, Cass County, reports most drinking water carried to homes, spring water is hauled and that snow and ice is melted for use. They state that they have ten wells in town and that more are needed.

Kindred, Cass County, states that water is carried into the homes and hauled for the villagers from the farmers nearby. Some snow and ice is melted and used. Only four wells are enumerated for the village at from 30 to 300 feet deep. They have a public well.

Litchville, Barnes County, draws water from an artesian well with sufficient pressure for the water to be piped to the homes using a pump only for fire protection and for the school. Naturally, there is no attempt to meter the supply. The depth of the artesian well is not given but it must reach the

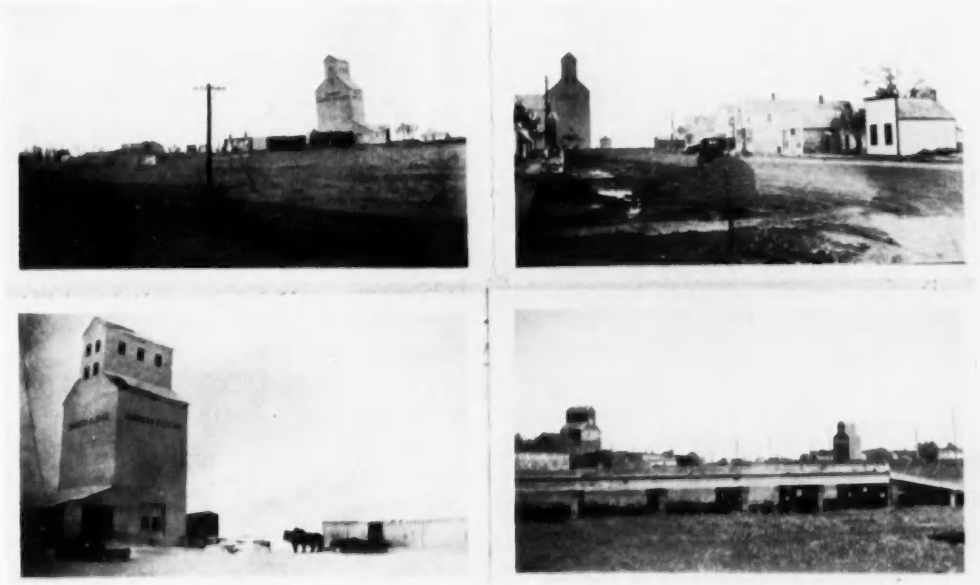

FIGURE 1.—Plates A and B are small shipping points north of Fargo on U. S. Highway 81.
Plate C is a winter scene of a shipping point just south of Crookston, Minnesota.
Plate D is Glyndon, Minnesota just east of Moorhead. These are characteristic scenes of shipping points and villages in the Red River Basin.

Dakota Sandstone for drinking water is obtained from the shallower wells at 40, 50, and 90 feet. The Dakota Sandstone water supply is not usually used for drinking.

Maddock, Benson County, must have some kind of organized supply for they list a reservoir as their source and state nothing about supplementary supplies. Their sewage, however, is listed as private septic tanks, "if any," indicating that their organization is not complete if they have one.

Mapleton, Cass County—through the efforts and courtesy of Mr. Walter Fogle, School Superintendent, reports as follows: "Ice and snow are used quite extensively as a source of water supply in Mapleton. Farmers—both those who have their homes located in the town and those in the country—are the greatest users of ice. Each farmer has an ice house of his own built close to his house. Ice storage is usually done in January, although it varies somewhat with weather conditions. This ice is used as a supply of water for drinking and cooking, and enough is stored for a year's supply.

"There are only two sources of well water in Mapleton, and as it is no fun carrying water in the winter, many of the people get a truckload of ice and have it stored in a shady spot, and melt it for drinking and cooking purposes. Although the majority of people have cisterns and use rain water for washing purposes, some do not, and after the rain water stored in barrels has been exhausted, they melt ice for washing purposes.

"During the very dry years a good clean snowfall is very welcome and during the two years of such heavy snows, a few years ago, a great deal of snow was melted, as the huge drifts of snow made it impossible to haul ice into the yards. I have never heard of snow water being used for drinking purposes in Mapleton. When there is an ice supply available most people do not bother with snow unless they are very poor. I have seen children of families on relief out trying to shovel up a little snow when it was hardly visible. When there is a late spring with little rain and the ice supply is exhausted it really is quite a problem to get soft water. The two wells in town furnish extremely hard water which cannot be used for washing purposes.

"There are several sources of supply for ice around Mapleton. There is a dam on the Maple River, a few miles out of Mapleton, and much ice is cut there. Some get it from Fargo, and some from the dam at Prosper. All of this ice is supposed to rate quite highly as drinking water, as some of the farmers claim to have had the different kinds tested at the Agricultural College. The Fargo and Prosper ice were supposed to rate the highest. I believe the ice from Fargo is out of Detroit Lakes, although I am not sure. The price is ten cents a hundred pounds. Most farmers have wells to obtain water for their cattle but do not use it for human consumption."

Michigan City, Nelson County, has no wells within the town limits and replies that they have plenty of water, yet need more wells. The wells are commonly 100 feet deep ranging from 30 to 110 feet. No bedrock is reported. They list no hauling of water or no snow or ice for water supply but have cisterns.

Milnor, Sargent County, is fortunate in having an artesian well supply with water piped to 95 per cent of the homes and probably no water carried. They have some organization using a "Party Line" system based on six artesian wells. No water is hauled and no snow or ice melted. Nature apparently has relieved them of these other water supply recourses, but they report that "the artesian wells are getting a little weak."

Milton, Cavalier County, gets its water supply from one public well and from private wells. They list cisterns, melting of snow and ice, and hauling from a dam one and one-half miles from town as supplementary supply. Well depth is placed at 25 feet. A few homes have private pressure systems. Some of the wells are reported inadequate and the school reports a low supply around January first.

Page, Cass County, says that all homes have wells and gives the depth at from 85 to 100 feet. They have cisterns with inside pumps and haul melted snow water from one-half mile out of town.

Portland, Traill County, lists well, cistern, spring, and snow and ice as their water supply. Spring water is delivered, hauled by truck from six and eight miles out of town from two springs. The well depth prevails at 30 feet. The most pressing problem is listed as "enough rain to fill cisterns."

Saint Thomas, Pembina County, does not fill out the questionnaire but writes, "We do not have a city water system for any other use than fire prevention. The water for this system is furnished by an artesian well with a cistern for a reservoir. This water is not fit for human consumption. Other water supply in the city is mainly from the cisterns privately owned. We have three or four shallow wells that are privately owned and used."

Sanborn, Barnes County, writes that most of the drinking water and about 90 per cent of water for other purposes is carried to the homes. The supply is varied coming from cisterns both inside and outside for ten per cent of the homes, from wells and the Sandy River, from deserted farm cisterns, and from the Sheyenne River about 13 miles distant. Snow and ice is used. The well depths prevail at 25 feet, the deepest being 45 feet. They report that they need more soft water.

Sarles, Cavalier County, has ten cisterns and five wells. Cisterns are reported as both in and outside the homes, and well water is piped into homes. Water is reported carried, and hauling of water is done from the school well. Wells are from 75 to 150 feet deep with no bedrock being reached. Some snow and ice is used and they state their most pressing problem is the inconvenience of carrying water.

Sharon, Steele County (population 371 in 1940), has been reported with considerable detail through the efforts of Mr. William Peterson, high school instructor. The extent and detail of Mr. Peterson's investigation of the water supply situation in and about Sharon is to be highly commended. It is only through reports of this nature that projects for water supply betterment can be planned.

Figure 2 is a map of Sharon, made by

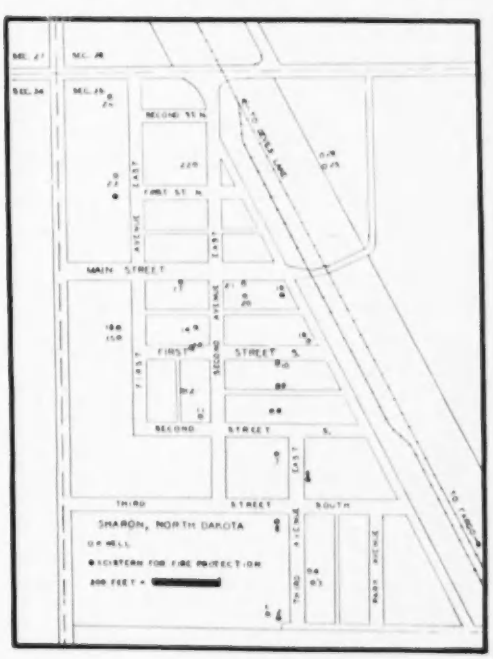

FIGURE 2.—Map of the city of Sharon, North Dakota showing wells for water supply.

Mr. Peterson, and shows the distribution of the village water supply. *Well 1*, was dug in 1930, has not been used since 1936 for it was filled in because the water was polluted by silage juice draining into the well in 1939. There was ample water in this well as it was located in a depression about ten feet below the general level.

Well 2, was dug in 1921; cleaned out in 1939. It is never dry but has a poor taste.

Well 3, was dug in 1916 and filled in 1930; barn was moved from the location and poor taste of water caused well to be abandoned.

Well 4, dug 1924, supplies one house with running water, which has private pressure system.

Well 5, is 72 feet deep; was drilled in about 1910. It is now dry but may be due to poor casing and cave in; it was poor drinking water.

Well 6 is the school well; dug in 1915, never dry. It is 90–95 feet deep; mineral content is noticeable but taste is fairly good.

Well 7, used to be the main well in the southern part of town before 1915; pumps wore out so fast that the owner abandoned the well and filled it in. It has a good taste and quite soft.

Well 8 is 68 feet deep; dug in 1930; ample supply for one house with private pressure system located in the basement.

Well 9, 72 feet deep; a city well is the main source of drinking water between schoolhouse and Main Street; it is the source of water supply for all but one house in that block and in the south half of the block to the north; has been pumped dry but fills in again slowly; has never gone completely dry; dug in 1910.

Well 10, 74 feet deep, is not used because of its poor taste; small water supply; pumps dry in about two hours with 600 gallon yield; will slowly fill in again.

Well 11 is 70 feet deep; was dug about 1910; it is never dry and supplies one house.

Well 12 is 65 feet deep; dug about 1908; poor taste; used by three families for washing.

Well 13 is 70 feet deep; dug in 1898; filled in 1910 and was the first city well. It was located on the street so it was filled in; it has good supply; quite soft; good taste; used for steam engines.

Well 14 is over 60 feet deep; it has a poor taste. It was dug for power house which now uses Diesel engines to pull generators and is used very little.

Well 15 is 22 feet deep; was dug following the World War but has been dry for several years.

Well 16, 22 feet deep; was dug following the World War and has been dry for the past several years.

Well 17 is 56 feet deep; fair tasting water; used to supply a storage battery factory; factory moved out in 1928; someone stole the pump.

Well 18, 72 feet deep, was drilled in 1940; is not cased as yet; water rose about 30 feet in well; the landlord where Mr. Peterson rooms located this well with a willow stick and determined roughly the depth to be drilled by waving a brass rod up and down. Mr. Peterson's landlord has a well-drilling outfit and hopes to start a well-drilling career.

Well 19 was formerly used by the hotel. It was dug in 1935 and is now used for hospital. Supply is ample and water fair quality.

Well 20 was dug in 1910, 22 feet deep; filled in 1920. The water was poor in quality and was used for livestock—mainly horses. Cars have rendered it useless; farmers coming to town used to water horses there.

Well 21, 14 feet deep, is located in the basement of the store and meat market;

it was dug in 1925; alkali; and has a small supply. It was dry for a time in the spring of 1939. It is used for washing meat market equipment.

Well 22, 55 feet deep, was dug in 1900. It formerly had plenty of water but was filled in partly by stones possibly for clearing the water by filtration; present depth is 40 feet and supply is small.

Well 23, 72 feet deep, was drilled about 1920; has a small flow.

FIGURE 3.—Plate A is a small town cement factory at Downer, Minnesota.
Plate B is a small town school near Warren, Minnesota—such schools usually have their own water supply pressure system.
Plate C shows the haphazard manner of sewage disposal in some of the small towns.
Plate D is a dug reservoir just east of Moorhead for the Northern Pacific Railroad water supply.

Well 24, 73 feet deep, is the oldest well in town. The water is fairly soft and of good taste. It was dug about 1890 but caved in about 1930.

Well 25, 160 feet deep, has a good water supply but is not conveniently located. A flour mill formerly was adjacent to the well but the mill moved out after the World War.

Well 26 is an attempt of the flour mill to find water by drilling deep—600–700 feet. The attempt was abandoned when no satisfactory results were obtained; returned to using the 160 foot well number 25.

Sheyenne, Eddy County, lists cisterns and private wells. Water is carried to the homes and hauled from the river about one-half mile distant. Snow and ice is not melted. Wells are 20 to 25 feet deep. Wells enumerated in the town total 40. Water is reported pure and plentiful.

Tower City, Cass County, reports 12 wells within the corporation limits with six or eight in use. Cisterns, snow and ice, and hauling from the school well augment the supply. Water is carried in some cases. They state that they need more wells.

This intimate view of a village water supply without any public organization is repeated scores of times in the Red River Basin. It not only reveals the intimate dependence on well water, but also the continuous effort necessary to

keep the well in good condition for use. Furthermore, most of the inhabitants of Sharon must carry at least their supply of drinking water from well to home, although some water is brought in by a farmer and sold for drinking purposes.

It may be possible in the future to build such village units into some form of organized water supply system.

POPULATION OF SOUTHERN UTAH

Herbert E. Gregory

IN planning their western exodus the leaders of the Church of Latter Day Saints outlined the "State of Deseret"—a vast area that comprised the present Utah and Nevada, most of Arizona, half of Colorado, and parts of Idaho, Wyoming, Oregon, California, and New Mexico. As this little known region was thought available for colonization—and dominance—by the Church, it became imperative to ascertain its character and potential resources.

The Latter Day Saints reached the shores of Great Salt Lake in the summer of 1847 and within a few months began a geographic study of their chosen homeland. They gave first attention to the narrow belt of flat country along the west base of the Wasatch Range and the Pavant, Tushar, and Markagunt Plateaus, where practical routes of traverse had been marked out by trappers, traders, and exploring parties, and where Indians were few. Superficial observation had shown that the adjacent parts of Utah were either alkaline deserts or rough lands of mountains and canyons, occupied by vigorous, generally hostile Utes. The decision to give priority to the examination of "the lands along the mountains" was fortunate. Preliminary scouting revealed areas of fertile, easily tilled land, which could be irrigated at small cost—oases in a region of bare rock and dry sand—and, as exploration progressed during the decade 1850–1860, more than 50 oases in a belt two to 10 miles wide and extending nearly across Utah were found to be suitable for settlement. In southwestern Utah oases at the mouths of canyoned streams that reach back into the Markagunt Plateau attracted the pioneers to Paragonah, Parowan, Summit, Cedar City, Fort Hamilton, Kanarra, Pintura, Toquerville, and La Verkin, and farther north many similar sites were occupied; in fact, this belt of oases has proved to be the most prosperous part of Utah. Within it reside about 80 per cent of the population of the state, and more than 40 per cent of the population in the entire intermountain region. It is interesting to note that because the "Oasis of Utah" was first settled the colonization of Utah progressed from west to east and thus differs from most pioneering activities in neighboring regions. In southern Utah the villages at the base of Hurricane Cliff were founded in 1850–1860, then in turn those in the Parunuweap, Kanab, Johnson, Sevier, Paria, and Escalante Valleys (1864–1878), and in the San Juan country (1880–1890).

Unlike most other parts of the United States, where the pioneers individually selected home sites widely scattered on prairies, in the mountains, along streams, and in woodlands, Utah was systematically colonized as self-sufficient villages and the history of the state is concerned chiefly with the growth of the original settlements. Practically the entire population of the counties considered in this survey—San Juan, Kane, Garfield, eastern Iron, and eastern Washington—has always been restricted to villages which are surrounded by large areas of uninhabited land. The farmer lives on a town lot, which constitutes his garden and orchard, and

goes back and forth to his dry land or irrigated tract at various distances and directions from home. Likewise the stockmen live in the villages and only in the summer season occupy wagon camps or cabins where their sheep and cattle may receive closer attention; homesteads along country roads are exceedingly rare. Diaries of the pioneers show that for two years Levi Savage lived alone at Kanab and that for three years Don Carlos Shirts was the sole resident of Paria Valley. But most sites were first occupied by groups of families. Long wagon trains loaded with men, women, and children, tools and household furniture, and trailed by milk cows, were hauled by oxen or horses over roadless tracts and unloaded at the chosen spot. Within a few weeks after the first caravans arrived Toquerville enrolled eight families; Virgin City, Kanab, Asay, and Hillsdale about 15 each; Parowan, 35; and St. George, 65. Available records show that none of the original settlements enrolled less than 25 people and that generally within a few years the pioneer families were joined by others. This grouping of the population into rather compact settlements is in accord with geographic conditions, but in large part was deliberately planned to bring to rural communities certain social, educational, and economic advantages otherwise possible only in urban centers. Even the smaller settlements had "meeting houses," school buildings, dance halls, and picnic grounds.

The colonization scheme of the Mormon Church included not only the choice of a site which scouts had thought favorable for agriculture, but also the selection of individuals to insure skilled amateur leadership in the various activities necessary in places far removed from markets and sources of supply. Though their interests and attainments were varied, the colonists were closely held together by a common bond: "unfaltering faith in the leadership of the Church." The Saints "called" to found a colony included farmers, stockmen, masons, carpenters, weavers, blacksmiths, painters, shoemakers, harness makers, and other artisans, and for some settlements, teachers. In these groups professional physicians are conspicuously lacking. Home remedies were devised and skillfully applied but the chief reliance seems to have been on "cures by faith." Of late years Cedar City has become a medical center and Hurricane has a resident physician and hospital, but even today only one local physician is available to the 5,000 people in Garfield County; Kane and San Juan Counties, with a combined population exceeding 7,000, have no resident physician or dentist.

Apparently the pioneer settlements were organized in anticipation of conflict with the Indians. At each chosen site the first structure was a "fort," built of upright logs, adobe, or rock, large enough and suitably equipped to accommodate the entire population in times of siege. Southern Utah in the decade 1860–1870 has been described as a "string of stockades and forts"; however, such protective enclosures were little used. The Piutes were generally friendly; the Utes restricted their warlike activities to northern Utah; and the Navajos proved to be thieves rather than murderers. However, at times fear of the Indians made life in the frontier villages and outlying farms precarious. For a few years beginning in 1866 the people lived close to the forts; the occupants of small villages moved to larger ones and some settlements in Kane and Garfield Counties were abandoned.

Under the controls imposed by their organization, environment, and purpose,

the life of these pioneer communities must have been interesting though somewhat primitive. Typical of most settlements were the conditions at Rockville, as described in an interview with James H. Jennings, a pioneer of the sixties.

"Most of the people came by ox-team and were Mormons called by Brigham Young. We camped right in the brush and went to grubbing the same day. The main purpose of our coming was to grow cotton. Other crops were sorghum, corn, and a little wheat. We lived on molasses pretty much. We traded sorghum for potatoes with the northern settlements. Corn was to feed pigs. Old man Petty made a corn grinder. Later he got a cloth bolt and bolted flour. The town had about 100 head of cattle which, though privately owned, were treated as a community herd and the milk, butter, and cheese were equitably distributed. If you had three cows you herded three days, then the next man would take his turn. One day herding for each cow. We lived from our cows pretty much. [Edija] Newman was a millwright who came from Parowan where lumber was sawed for the Tabernacle organ in Salt Lake City. John C. Hall was a great student; his wife was a nurse. Samuel Kenner was a musician; he made fun for us. William N. Carpenter had a lathe and turned out wooden bowls which he traded up north. He also took cottonwood logs, cut out the inside, put a head on each end, and you had a barrel. Henry Stock was a molder; he made a sorghum mill. We wore buckskin pants. I had one pair of shoes when I came. These lasted a long time as I went barefoot for five years. Mail from the north came once a week by ox-team or on foot from Virgin where it had come from Toquerville [Settled in 1858]. It consisted of the weekly Deseret News and a letter once in a while. Mail from Kanab and Pipe Springs was let down the cliffs near the mouth of the Parunuweap on a wire cable. Until the mill was established at Washington [1865] the home-grown cotton was locally ginned and the women would weave the cloth themselves. Copperas from a petrified log near Northrup was used to set the dye. The first year we made dugouts in the river banks. Next year they got to building log houses. The only gun my dad had was an old flintlock musket. Mr. Petty made a cap and ball gun out of it. No people were killed by Indians around here; the Berry boys were killed at Short Creek.

"A few Indians [followers of Chief Muhin (?)] lived at Rockville and at Virgin but I have never known Indians to live above Springdale. I noticed they would go up to kill deer in Zion Canyon but were always in a hurry to get back. The Piutes seemed peaceful enough and were well treated. Brigham Young said 'it was cheaper to feed them than fight them.' The trouble was with the Navajos. In fear of Navajo raids the residents of adjoining settlements moved to Rockville [1866]. Some bought places and built houses. The women remained for three or four years; the men went back and forth to care for their crops. Under Jim Andrus every able-bodied man and boy was enlisted in a military organization. They would put a kid with an older man to stand guard."

The primitive conditions that for many years characterized the pioneer villages was due largely to isolation. The materials needed for home building and farming necessarily came by wagon and pack train, over undeveloped roads and bridgeless streams—trips made in one to six months from Salt Lake City (300–350 miles), California, or Missouri River points. It is reported that

"in the early days nails cost 80 cents a pound, an ax $10, a spade $5, a plow $150, and the poorest grade of cotton cloth 75 cents a yard. The cost of wire and ordinary tools of iron and steel was almost prohibitive; utensils of copper, brass, and tin could not be obtained; and linen and silk were unknown." Under such circumstances the failure of attempts to make profitable use of the iron ores near Cedar City and to develop the Virgin River Valley into a "cotton raising empire" must have been particularly disheartening. The hardships imposed by isolation were somewhat lessened by the construction of railways to Ogden (1869), and, in more recent times, to Marysvale (1900) and Cedar City (1923), but as yet no railroad enters Washington, Kane, Garfield, or San Juan counties. However, the anticipated extensions of the Union Pacific or the Rio Grande Western railways to St. George, Kanab, and Blanding are now of little interest; the present railheads are conveniently reached over Federal and State highways—outstanding contributions to the welfare of southern Utah. The construction of these highways, during the years 1925–1935, involved drilling the mile-long Pine Creek tunnel; blasting out the rock ledges in Long Valley, Red Canyon, Tropic Canyon, and at the divide north of Pintura; building roads up the Hurricane Cliffs and across the Markagunt, Paunsaugunt, and Aquarius Plateaus; and bridging Ash Creek, and the Parunuweap, Sevier, Green, and Colorado Rivers—engineering tasks that demanded skill and financial resources far beyond the reach of the local communities. These new roads give ready access to the outside world by automobiles, trucks, and horse teams, and they have made communication between the villages easy by replacing the rough roundabout wagon trails in use for more than 60 years.

Because their sites include but a few hundred acres of irrigable land, most of the villages in southern Utah are small. Of 67 settlements important enough to be shown on the state highway maps of Iron, Garfield, Washington, Kane, and San Juan counties, 56 enroll less than 500 persons—most of them less than 200. The population of six settlements is listed as 1,000 to 2,000 and only two, St. George and Cedar City, as more than 3,000. In order to utilize the water from a common source Virgin, Grafton, Rockville, and Springdale and the abandoned towns of Duncan, Adventure, and Northrup lie in a narrow belt only 14 miles long; Henrieville, Cannonville, and Tropic are within an area about six miles in diameter; and the borders of Mt. Carmel, Orderville, and Glendale overlap.

Official records, manuscript diaries, and conversations with "old timers" make it clear that the Mormon colonists thought of southern Utah as primarily an undeveloped "agricultural empire" adapted for the raising of grain, cotton, garden produce, and fruit, and that the income from irrigated farms could be supplemented by the exploitation of timber, mineral resources, and grazing lands. However, experience of the first 30 years showed that the acreage suitably placed for irrigation without prohibitive cost was smaller and more difficult to maintain in tillage than had been expected; that cotton—the anticipated chief crop—could not be grown with profit; that the iron ore could not be satisfactorily smelted; and that the coal was of only fair quality and so costly to mine that wood was generally preferred for fuel. For a time it seemed that the discovery of silver at Harrisburg in 1869 and of gold on sand bars in Grand Canyon in 1872 would

lead to a permanent mineral industry. But within 10 years the profitable ore in the fabulously rich Silver Reef was exhausted and Bonanza City with its 1,500 inhabitants had become a ghost town. The search for gold along the Colorado River proved futile; the "swarm of placer miners" returned empty handed.

The cessation of mining and the failure of the elaborate schemes to raise and process cotton, left the pioneers of 1880 about where they began in 1851–1860—communities of farmers who owned orchards, gardens, and sufficient livestock to supply milk and meat chiefly for local use. With a decrease in acreage of farm lands owing to destruction by flooded streams, and increasing population, financial support became more and more dependent on the income from live stock. Nowadays the profitable exports are cattle, sheep, hogs, wool, and fruit.

The development of the livestock industry in southern Utah illustrates the control exercised by topography and in much greater degree by climate. In this semiarid region the natural herbage is scanty and when destroyed reproduces itself with seeming difficulty. Its relative abundance depends on the snows and rains which show wide and unpredictable seasonal and annual variations in amount and distribution. The evidence is conclusive that during the period 1850–1880 grass and other succulent herbage was abundant in the canyons and lowlands and on the high plateaus and that conveniently placed springs and streams provided the necessary water. In pioneer days grass was so plentiful that milch cows and even small herds of beef cattle could be pastured near the settlements and returned to corrals at night. As the livestock increased in number and the local forage became less abundant near the irrigated tracts, herd grounds were selected on nearby highlands in the summer and on the lower plains during winter, and the same grounds might be occupied in successive years. With additional increase in cattle and the introduction of sheep more distant range lands were utilized, especially the vast areas on the Markagunt, Paunsaugunt, Shiwits, and Kaibab Plateaus, in House Rock Valley, and along the Grand and Glen Canyons of the Colorado—districts that comprise about 21,000 square miles in southern Utah and 9,000 square miles on the adjacent Arizona Strip. By 1880 in Iron, Washington, and western Kane counties and by 1890 in San Juan and eastern Garfield counties, the larger areas of well grassed range land seems to have been fully stocked and some of the less desirable lands were brought into use. Under these conditions decreases in amount of precipitation and consequent loss of pasturage meant catastrophe. It is reported that during the severe drought of 1896–1900 "about half the cattle died of starvation." For some settlements the financial support dwindled or disappeared; shifting of population and abandonment of home sites are many times recorded. With the return of normal years stock raising expanded to its maximum but under changed conditions. To a considerable degree owners of small herds were replaced by incorporated companies with capital sufficient to restock the range and to develop adequate water supplies, especially on the Arizona Strip. But investment by these big companies was in large part misplaced. The large herds soon depleted the range that had not fully recovered from previous long droughts and the introduction of sheep made systematic range management impracticable. As an aid in restoring favorable conditions national forests were established, beginning 1902.

During the past quarter century even more than in previous years, the history of the livestock industry in southern Utah records the changing climatic conditions. Most of the region is overgrazed and even slight fluctuation in rainfall and snowfall determines the amount of forage—meager or less meager. In normal years such livestock as can be accommodated in the national forests graze on the plateau tops during the summer, on the foothills during fall and spring, and on the lower, more arid regions in winter.

Outside of the national forests in years of adequate rainfall the cattle, and the sheep that have largely replaced them, fare reasonably well, and when high prices prevail the financial returns are surprisingly large. But during such dry years as 1919, 1924, 1928, and 1933, and at times of low prices, the conditions are highly unsatisfactory. Though natural forage on the unappropriated public lands is now deficient and is being replaced by sagebrush and introduced annuals, it is still much in demand. The cost of feeding animals on harvested crops is four to eight times that on the open range. Probably less than eight per cent of the stock is fed in pastures, four to six months a year.

The population of southern Utah has always been small and its growth somewhat surprisingly slow. Since 1880, when all but four of the present settlements had been organized, the population increase has been about 18,000, and fully half of it is due to the growth of Cedar City and St. George and the founding under artificial conditions of Tropic (1891), Blanding (1905), and Hurricane and La Verkin (1906). In the pioneer days the increase in population was rapid—the result of immigration. Between 1851 and 1859 nearly 2,000 persons moved into uninhabited Iron and Washington counties and in 1870 the estimated number of immigrants was 5,000. From 1870 to 1920 the increase was almost wholly natural—the excess of births over deaths—which, for southern Utah is about twice that for the whole United States. During the 1890's the increase had become so rapid that about 50 families found it advisable to migrate from Iron County to Oregon, Idaho, and Wyoming. For the decade 1920–30 the census again records a large natural increase and also considerable immigration to Iron County and emigration from Garfield County. During this period the increase in the five counties under review is recorded as 24.9, 9.7, 8.8, 3.5, and –2.6 per cent. In more thickly settled regions these figures would imply substantial increase or decrease in population. For southern Utah they imply that on the average only about 134 people were added each year to the population of Iron County, 66 to Washington County, 80 to Kane County, and 12 to San Juan County, and that 37 left Garfield County. Beginning about 1925 an increase in population has resulted from the notable changes in economic conditions: the coming of the railroad to Cedar City; enlargement and fuller utilization of the national forests; allotments of grazing lands under Federal supervision; the construction of Federal highways; the large-scale development of orchards at Hurricane and La Verkin; profitable iron mining; and the establishment of Zion and Bryce Canyon National Parks, with their enormous tourist traffic. Much of the increase is recorded by Cedar City, which includes 57 per cent of the population of Iron County and by St. George and Hurricane, which together enroll 53 per cent of the inhabitants of Washington County. Since 1880 the population of several villages has been about static but most of the long established places record a con-

sistent, small increase. Of the 63 settlements listed in the accompanying tables, 13 show decreases and 14 have been abandoned, and many outlying ranch farms are no longer occupied. In 1940, 30,126 persons in southern Utah occupied 22,931 square miles of land—an area about four times the size of Connecticut and half the size of Pennsylvania, Ohio, or Tennessee. The resulting density of population is about 1.3 a square mile; for the small Washington County, 3.8, and for Kane and San Juan Counties 0.6. For the adjoining Arizona Strip it is about 0.001.

At first sight these figures seem small for a region settled 70 to 80 years ago by an unusually industrious people but it adequately represents the "carrying capacity" of southern Utah: lands suitable for dryland and irrigation farming seem to be fully utilized and the grazing land is fully stocked—some of it overstocked. In years when crops are ruined by the destruction of irrigation ditches, by insect pests, or drought, and years when scant forage or low prices make stock raising unprofitable, many men and some women and children "go outside" to earn living for their families. But this shifting of the population has rarely resulted in a permanent loss to the village; when the reason for their absence no longer holds, the men temporarily employed as miners, lumbermen, carpenters, and masons return to their homes. Possible migration to "better places" usually seems to receive scant consideration.

To a degree probably not duplicated elsewhere, the population of southern Utah is marked by racial purity and homogeneous culture. Originally it consisted of Nordic immigrants from Great Britain, Scandinavia, Germany, Switzerland, and the eastern United States, and most of the present inhabitants are the descendants of the pioneer settler whose families are related through marriage. Fully 99 per cent are members of the Mormon Church and therefore have a common interest in the spiritual, intellectual, and economic development of their chosen home.

Founding and Development of the Settlements

Base of the Hurricane Cliffs

The Latter Day Church Saints reached Salt Lake City in July, 1847, and almost immediately dispatched scouting parties into the surrounding regions. In the fall of 1847 a party under the leadership of Captain Jefferson Hunt en route to California traversed the country between Great Salt Lake and Little Salt Lake near Paragonah, and beginning in December 1849 a reconnaissance survey of the region along the base of the Markagunt Plateau and southward along the Hurricane Cliffs to the Virgin River was made by Parley P. Pratt, who recommended that Little Salt Lake Valley be colonized. In January, 1851, the Iron County Mission—119 men, 30 women, and 18 children—reached Center (Parowan) Creek—the site chosen for settlement. Thus Parowan (originally named "Louisa") became the pioneer village in southern Utah, in fact the first settlement south of Provo—200 miles distant. Almost immediately on arrival the essential first tasks began. Land was cleared and plowed for crops, irrigation ditches were dug, timber was brought from the mountains, and for protection against possible Indian raids a log house was constructed—large enough to accommodate the entire population. Within a few years the original "meeting house" was replaced by a "fort"—56 rods square, surrounded by earth and timber walls 12 feet high.

Evidently Parowan was designed as the administrative, commercial, and

ecclesiastical center for a vast region. Before the first settlers arrived the contemplated village was made the county seat of Iron County—established by decree in 1850 as a strip of uninhabited country about 100 miles wide that extended from the Rocky to the Sierra Nevada Mountains and before the settlement was fully organized it was granted a city charter—an honor shared only by Salt Lake City, Ogden, Provo, and Manti. The records suggest that the pioneer settlers saw an opportunity to develop Little Salt Lake Valley into a second Great Salt Lake Valley and to bring the surrounding region within the range of their influence. In 1851 and 1852 the "suburban villages" of Cedar City, Paragonah, Fort Johnson (Enoch), and Fort Harmony were colonized, and scouting parties reported on potential farm lands, grazing districts, and village sites in Ash Creek, Virgin, Sevier, and Parunuweap valleys. Citizens of Parowan took the leading part in the founding of Santa Clara (1854); Beaver and Minersville (1856); Washington (1857); Toquerville, Virgin City, and Pioche, Nevada (1858); St. George (1861–62); Panaca and Panguitch (1864); Bluff (1880); and also Snowflake, Arizona, and Big Horn, Wyoming. Parowan has been appropriately dubbed the "mother of the south." For nearly 40 years it was the largest village in southern Utah and adjacent parts of Nevada, Arizona, and Colorado. At present the population of Parowan is exceeded in southern Utah by Cedar City, St. George, and Panguitch and in consequence of eleven changes in the boundary lines of Iron County its political control has been decreased. It remains a prosperous village of attractive homes for farmers on adjoining lands and for stockmen who utilize the forage on the Piute Highlands and the Dixie National Forest.

Cedar City (Cedar Fort) received its first settlers in the fall of 1851—35 men from the Iron County Mission of Parowan who constructed a fort and began the cultivation of lands on Muddy Creek (now Coal Creek), about a mile north of the present village. To provide more favorable conditions for the rapidly increasing population the tiny village was moved in 1853, and in 1856 disastrous floods forced a second relocation. Though the site was recognized as suitable for irrigation farming and stock raising it was chosen primarily as a manufacturing center. Iron ore at Iron Springs and coal in Coal Canyon aroused hopes of a "western Pittsburgh." "There was awakened in the Latter Day Saints a special desire to establish iron foundries." Promptly mines were opened, an experimental

TABLE I

EASTERN IRON COUNTY

Settlement	*1851*	*1860*	*1870*	*1880*	*1890–*	*1900*	*1910*	*1920*	*1930*	*1940*
Cedar City (1851)	...	301	517	892	1053	1530	1802[1]	2462	3615	4695
Fort Hamilton (1870)	...	....	16	....	30	36	....	....	24	16
Kanarraville (1861)	...	....	....	....	282	225	249	326	270	309
Paragonah (1852)	...[2]	....	211	256	268	358	399	449	384	365
Parowan (1851)	...	526	861	957	....	1039	1156	1640	1475	1525
Summit (1859)	...	49	174	123	143	135	107	154	157	151
Other villages and farms	...	....	....	....	....	260	223	775	1034	2042
COUNTY	445	1010	2277	4013[3]	2683	3546	3933	5787	7227	8331

[1] Figures for Cedar City and Parowan prior to 1920 include adjoining settlements.
[2] Reported as 25 families in 1853.
[3] The census figure (4013) includes 1600 persons in the present Garfield County, organized in 1882. The Mormon Church ecords the population of Iron County in 1880 as 1987.

furnace was constructed, coal was hauled by sledges from the nearest outcrop, and a foundry and blacksmith shops were built. Owing to the lack of experienced workmen in Utah a call was sent to the Saints in England and Wales for miners, for "men who could make iron and machinery for slitting and cutting nails and drawing wire." These pioneer operations were suspended in 1856 and renewed attempts to work the iron (1868, 1871, 1879) resulted in failure. Recent large-scale mining and transport of the ore to Provo for smelting are "outside operations" of little concern to Cedar City. The growth of the city since 1920 is a measure of the economic change brought about by the construction of a railroad (1923)—the only one in southern Utah—and the development of Federal highways since 1930; both due in large part to the demand for ready access to southern Nevada and California and to regions of scenic interest in southern Utah and northern Arizona. In 1940 Cedar City had about 57 per cent of the population of Iron County.

During the first decade of colonization the only settlements along the Hurricane Cliffs south of Coal Creek were tiny Fort Hamilton and Toquerville, and the only other settlements in southern Utah were the tiny outposts at Fort Harmony (New Harmony) and Santa Clara.

For ten years after they were founded Parowan, and in less degree Cedar City, provided homes and markets for the families who derived their income from grazing and farming in southern Iron County and southward to the Virgin River in the present Washington County. To utilize the waters of Shirts Creek, Fort Hamilton, originally called Fort Walker (1851) and later "Sidon" was selected as a home site by Peter Shirts and was later occupied by "old man Hamilton, his two sons, Samuel and John, and three other families." The settlement, never large, is now in part abandoned. In 1862 cattlemen founded Kanarraville, a site near their herd grounds, and within reach of the water from Kanarra, Spring, and Camp Creeks. They organized the famous Kanarra Cattle Company, which conducted operations not only on the nearby Kolob Terrace and in Ash Creek Valley, but also on the Markagunt Plateau, the distant Kanab Valley and the Paunsaugunt Plateau.

South of Kanarraville, Pintura, founded as Bellevue in 1864, is the home of about seven families, who derive their livelihood from fields and orchards, which are irrigated by waters of South fork of Ash Creek.

Toquerville, the oldest settlement along the southern Hurricane Cliffs, was founded in 1858 by eight families from New Harmony. In 1859, 19 families were busy growing wheat, cotton, sorghum, planting grape vines and fruit trees, and attending to their community dairy herd on the grass land west of the village. During the next few years these pioneers built a grist mill, a saw mill, a cotton gin, and began the construction of the brick houses that give character to the present village. The history of the village records the stirring events connected with the colonization of southwest Utah: the successful adaptation of agriculture and horticultural practice to semi-tropical countries, the pest of grasshoppers, the advent of the United Order, and the persecutions of polygamists. Toquerville is favorably placed to utilize the waters from two strong springs in the bed of Ash Creek Canyon and the grazing lands in the nearby La Verkin Valley and on the high-lying Kolob Terrace. The springs yield abundant supply for the town and its outlying fields and orchards and also

TABLE II

GARFIELD COUNTY

Settlement	*1882*	*1890*	*1900*	*1910*	*1920*	*1930*	*1940*
Antimony[1] (1875)	200	....	211	229	227	281	328
Boulder (1889)	....	....	104	91	177	192	216
Cannonville (1877)	137	242	211	219	311	227	255
Clifton (1874)	60 (1876)	....	....	....	....	0	0
Escalante (1875)	441	530 ?	723	846	1032	862	1106
Hatch[2] (1880; 1900)	....	....	....	....	250	274	294
Henderson (1922?)	....	....	....	....	81	0	0
Henrieville (1877)	33	145	181	158	170	207	240
Hillsdale (1871)	....	....	251	180	250	22	6
New Clifton-Losee (1876)	12	7	6	....	....	....	0
Orton[3] (1876)	....	....	161	142	111	....	....
Panguitch (1864; 1871)	664	....	1194	1391	1473	1541	1979
Spry[3]	....	....	....	....	111	106	87
Tropic (1891)	....	194 (1894)	379	404	474	447	514
Widtsoe[4] (1910)	....	....	....	....	365	220	0
COUNTY	1613	2457	3400	3660	4768	4642	5253

[1] Organized as Marion Ward; post office Coyote. Name changed to Antimony 1921.
[2] Population records combined with Hillsdale 1900–1920.
[3] Name changed to Spry in 1911.
[4] Organized as Winder. Name changed to Widtsoe in 1915.

enough to provide water for household use at La Verkin and Hurricane.

Hurricane and La Verkin are the youngest villages in southwestern Utah; they were founded nearly 50 years after the other settlements along the base of the Hurricane Cliffs. To utilize their sites involved the conversion of dry, barren lands into fertile oases under exceptionally adverse conditions—a task that called for courage, determination, and ingenuity of the highest order. As early as 1865 it was recognized that the Hurricane Bench and the La Verkin Bench lacked only water to convert them into agricultural fields, and that abundant water ran in the canyon that separated the two tracts. Between 1870 and 1890 several schemes for utilizing the water were devised, but the cost of ditches and intake dams as recommended by engineers was prohibitive. Despite the discouraging reports, the settlers of the upper Virgin Valley were unwilling to abandon the scheme until the last possibility had been exhausted. New lands were needed to replace fields destroyed by floods in the upper river valley. "Our present lands cannot support more people, we must have more water or move away." Finally in July 1893, a committee of six men from Toquerville, Virgin, Rockville, and Springdale traversed the Timpoweap Canyon of the Virgin in search of a feasible ditch line. On their recommendation the villages decided to install an irrigation system that would bring "under ditch" 2,000 acres of land on Hurricane Bench, "no matter how difficult the work or what sacrifices must be made."

Beginning with a dam 15 feet high, "the Hurricane ditch," nine feet wide and nearly eight miles long, is cut in solid rock and talus and passes over trestles and through tunnels high on the precipitous canyon walls. For its construction no engineering equipment was available nor the services of skilled masons, drillers, or carpenters, and funds for the employment of labor were lacking. The ditch was dug by farmers and stockmen working with shovel, pick, and crowbar, mostly during the winter when fields and herds needed little attention. As compensation the workers were entitled to shares in the

new acreage. Construction began in 1893 and 11 years later the big ditch was completed. Two more years were required to clear the land and to dig the distributing canals. Beginning with 10 families in 1906, Hurricane has become a prosperous village of 1,500 people. Every acre of the watered land is cultivated.

Like the much larger Hurricane, La Verkin, colonized in 1900, is a man-made oasis. Its all-essential water comes from the Virgin River, through a ditch and a long tunnel continued as a pipeline that feeds the irrigation laterals and also the turbines of an electric power plant. Also like Hurricane, La Verkin has a separate system of pipes that carries water for household use from springs in Ash Creek north of Toquerville. Climate, soil, and water combine to make these two settlements a semi-tropical garden in which peaches, grapes, figs, almonds, walnuts, pecans, and pomegranates find a congenial environment. The La Verkin Hot Springs, that issue from the Hurricane fault at the mouth of Timpoweap canyon, is a popular resort.

VIRGIN RIVER VALLEY

Settlement of the Virgin River Valley east of Hurricane Cliffs—the "Upper Valley" as known to Mormon pioneers—was part of the project to make southwestern Utah a cotton raising "empire." Scouting of the valley by Nephi Johnson, who followed an Indian trail from Timpoweap Canyon well into Zion Canyon (1858), revealed a strip of fertile alluvial land nearly 20 miles long and in places as much as half a mile wide. Water from the Virgin, the Parunuweap, and North Creek was found to be more than sufficient to thoroughly irrigate all the "bottom lands" and adjoining benches that could practically be brought "under ditch." Building material was available, and the adjoining valleys and highlands afforded timber and excellent pasturage. On reporting his findings to the Church authorities, Johnson was instructed to establish a settlement in Upper Valley at the most suitable place. The response was the building of a crude wagon road—the "Johnson twist"—from Toquerville across the La Verkin River and over the Hurricane Cliffs, and the selection of a site which he named Virgin

TABLE III

EASTERN WASHINGTON COUNTY

Settlement	*1860*	*1870*	*1880*	*1890*	*1900*	*1910*	*1920*	*1930*	*1940*
Duncans Retreat (1861)	50[1, 2]	47	13 [2]	6[2]	.....	.....	.....	.....	0
Grafton (1859)	.....	168[1, 2]	71	104	98	106	46	23	16
Hurricane (1906)	.....	.....	.....	.....	.....	366	1021	1199	1524
La Verkin (1906)	.....	.....	.....	.....	.....	120	173	236	356
Little Zion	.....	6	14[2]	20	16	.....	.....	.....	0
Mountain Dell (1859)	33[2]	30	12	6	.....	.....	.....	.....	0
Northrup (1861)	.....	17[1, 2]	14	8	12 [2]	4[2]	.....	.....	0
Pintura (1864)	.....	35	27	31	42 [2]	.....	.....	.....	33
Rockville (1861)	70[1]	95[1, 2]	232	194	214	189	208	361	307
Shunesburg (1861)	.....	45[1, 2]	36 [2]	51[2]	8 [2]	.....	.....	.....	0
Springdale (1862)	.....	54[1]	50	73	144	186	204	351	454
Toquerville (1858)	95	.....	.....	.....	307	314	375	288	263
Virgin (1858)	79	336[1, 2]	254	213	269	136	212	202	154
COUNTY	691	3064	4235	4089	4612	5123	6764	7420	9269

[1] Church census July, 1864.
[2] Records of the Church of Latter Day Saints.

City, "destined to be the center of homes and commerce" for an anticipated large population. The pioneer families arrived in the early spring of 1858–59 and during the first year of settlement irrigation ditches were dug, crops from 70 acres were harvested, and a road was built up North Creek where a few families established the picturesque hamlet of Mountain Dell. The next few years were likewise prosperous despite the damage from flood waters and the demonstration that cotton planting was not profitable. In 1864 the village enrolled 336 inhabitants. From this maximum the population has declined to 154 (1940). Mountain Dell is now uninhabited and only one ranch house remains on North Creek.

In December 1859 four or five families under the leadership of Nathan C. Tenney established the town of Grafton about six miles above Virgin City. In the winter of 1861–62 the little village was destroyed by floods and relocated at the present site, two miles farther upstream, reached by fording the Virgin River. At the time of its maximum size, Grafton is described as an "attractive village surrounded by fertile lands." The site of the most profitable fields and of some garden plots and houses is now the bed of the river. The present population of 16 (1940) derive their livelihood largely from outside sources.

Duncans Retreat, founded in 1861 between Virgin City and Grafton is another village whose history records the losing struggle with the flood waters of the Virgin River. For 20 years after its settlement a small acreage of exceptionally fertile alluvial soil supported a population of about 50. By 1890 the river had taken away about half the irrigated acreage, and further destruction made farming unprofitable. The site of the settlement is now marked by a few foundation walls and fruit trees.

The history of Rockville begins with a settlement at the mouth of Huber Wash, established in 1860 by Phillip Klingdon Smith and others, under the name of Adventure. When the irrigation system was constructed it was found that much good land lay above the ditches, and high water in the winter of 1860–61 which nearly destroyed the buildings and farm lands showed that the lower lands were subject to disastrous flooding. In consequence the little town was relocated a mile upstream and renamed Rockville (December 13, 1861). During 1862 ditches were constructed, fields planted, dwellings built, and about a dozen families remained through the winter of 1862–63. In July 1864 the population of the new village was reported by the Mormon Church as 70; in 1870 as 95. During the decades 1880–1900, when the population was about 200, Rockville was recognized as one of the most beautiful and prosperous towns in Utah—a village of attractive stone houses, flower gardens, orchards, well tilled fields, and streets lined with stately mulberry and locust trees—and despite losses by floods and by the depletion of stock ranges Rockville remains a substantial settlement of 307 people (1940). To supplement their irrigated lands along the Virgin River the farmers of Rockville have cultivated the "Big Plain" back of Smithsonian Butte—an extensive area of successful "dry farming."

Shunesburg, near the mouth of Parunuweap Canyon, about four miles above Rockville, was chosen as a homesite by Oliver De Mille (1861) who bought the lands occupied by Shunes (Shoons, Shuns, Shurens), chief of the local Piutes. The following year four families arrived, and in 1864 the residents numbered 45. The site is an

alluvial flat of about 100 acres, readily irrigated by waters of Shunes Creek, South Creek, and the Parunuweap. For some 30 years the little village produced crops of corn, grapes, fruit, and grain, and by the construction of the famous "Wriggle Trail" (Shunesburg Trail) utilized the highlands above the canyon walls as pasturage for sheep and cattle. Members of the Wheeler and the Powell Surveys (1872) used Shunesburg as temporary field quarters. Destruction of arable land by widening of the stream beds and isolation from Rockville at times of floods caused abandonment of the site except during seasons of planting and harvesting. The ruined stone house, built by Christian Larsen for Oliver De Mille in 1886 (?), is a prominent landmark.

Northrup, on the Virgin River just above its junction with the Parunuweap, was founded in 1861 by four families under the leadership of James Lemon, who cultivated some 50 acres of land immediately adjoining the stream. The farms that escaped destruction by "washouts" are still in use, but the last dwelling house was vacated in 1910 (?).

Springdale received its first families about the same time as Rockville, Shunesburg, and Northrup. In fact, during the years 1861–63 most of the arable land along the Virgin River above Grafton was allotted as farms, and temporary houses were constructed. The first permanent settlers of Springdale arrived in November 1862, and by July 1864 nine families had established residence. Two years later all of them removed to the more populous Rockville where anticipated Indian raids could more surely be forestalled. In 1874 they returned to their farms and relo-

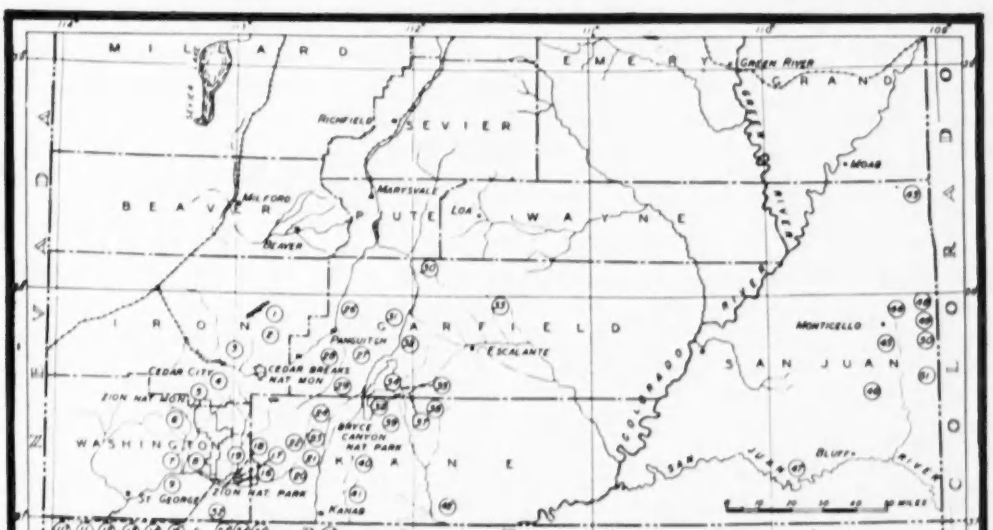

TABLE IV

KANE COUNTY

Settlement	*1860*	*1870*	*1880*	*1890*	*1900*	*1910*	*1920*	*1930*	*1940*
Alton (1908)	..	.....	.....	.....	.....	98	169	193	227
Georgetown (1886)	..	.....	.....	22	14	6	.....	.....	0
Glendale (1864)	..	.....	338	264[2]	319	244	250	239	297
Graham (1865)	[1]	[1]	30	30	.....	.....	.....	8	12 ?
Kanab (1863, 1870)	..	73[2, 3]	394	572[2]	710	733	1102	1195	1397
Johnson (1871)	..	.....	87	104[2]	62[2]	66	12	5	0
Mt. Carmel (1864)	..	200	137	122	137	131	143	133	187
Orderville (1875)	..	.....	514	429[2]	418	380	378	439	441
Paria (1865, 1871)	..	.....	85[2]	10	31	7	6	.....	0
Skutumpah (1870)	..	35	42	22 ?	.....	16	.....	8	5
Upper Kanab (1872)[4]	0	.....	106	111[2]	91[2]	.....	.....	.....	0
COUNTY	..	1513	3085[5]	1685	1811	1652	2054	2235	2557

[1] Reported as fourteen in 1865 and 34 in 1872. Since 1900 classed as part of Alton.
[2] Records of the Church of Latter Day Saints.
[3] Reported as 299 in 1872.
[4] In 1908, site of Upper Kanab changed and village renamed Alton.
[5] Includes population of districts annexed to Garfield and Washington counties in 1882.

cated their scattered dwellings at the site of the present village some distance back from the flood plain of the Virgin. Within a few years all the available acreage had been provided with water by ditches from the Virgin, the canyon floor above the mouth of Pine Creek had been utilized for pasturage, and the village had become known for its manufacture and export of rawhide bottom chairs. But opportunities for growth were not favorable. For about 50 years the village was an outpost at the end of a long, difficult road beyond which travel was restricted by canyon walls. The pioneer farms, though fertile and easily tilled, comprised but "375 acres," and cattle range was distant. To reach their grazing ground on the eastern Kolob Terrace the cattle were driven over the roundabout trail through Rockville, Cane Beds, and Mount Carmel. As a short cut for this 80-mile drive a trail, always dangerous, was built up the walls of Zion Canyon (1896)—the original route of the present East Rim Trail. Logs for houses were let down the cliffs. With these handicaps a population of 50 in 1880 and 73 in 1890 seemed a reasonable measure of the community resources. When the railroad reached Cedar City in 1923 a useful market less than 100 miles distant was for the first time available. Since the selection of the Virgin canyons as a national monument (1909, 1918) and their development into a national park (1919), and the construction of the famous tunnel road through the sandstone walls (1930), Springdale—"the gateway village"—has become much the largest settlement in Upper Virgin Valley.

Little Zion, a settlement shown on the United States Army maps of 1873–76, was the residence of a few families who cultivated small farms in Zion Canyon near the present Zion Canyon Lodge. According to James H. Jennings, Isaac Behunin (Behanin ?) was the first settler and gave the name to the canyon. Among his crops was tobacco—for the first time grown in southern Utah. Farming was continued by "four or five families" until about 1900. In 1870 the earliest known photographs of southern Utah scenery were taken by C. R. Savage.

The status of the pioneer settlements in upper Virgin Valley is recorded in the "Church Census," June–July 1864, as follows:

Virgin City and outlying farms, 56 families (336 individuals), 210 acres in crops; Duncan's Retreat, eight families (50 individuals), 40 acres; Grafton, 28 families (168 individuals), 40 acres; Rockville, 18 families (95 individuals), 105 acres; Shunesburg, seven families (45 individuals), 75 acres; Northrup, three families (17 individuals), 105 acres; Springdale, nine families (54 individuals), 110 acres. For all these villages the crops listed are the same: "wheat, corn, cane (sorghum), alfalfa, especially cotton, orchard fruit, and grapes."

PARUNUWEAP VALLEY

On their trip of exploration in 1852, John D. Lee and his associates found along the Parunuweap River "some handsome places for settlement in the narrow but fertile bottom of the stream." They reported that the central valley and the lower reaches of tributary valleys were easily irrigated; the adjoining high lands afforded excellent pasturage; timber for building was near at hand; and coal was available for fuel. This 20-mile stretch of river flat and low bench lands, locally known as Long Valley, was colonized in 1864, abandoned in 1866, and reoccupied in 1871. The Parunuweap Valley is the present site of farms, orchards, ranches, and coal mines, grouped about three villages whose borders overlap. In 1880 the population of the valley was recorded as 1,019—all the people that the restricted area could accommodate—and since that time has varied little. The decrease in population shown for the years 1910–1930 corresponds with the decrease in the quality of range lands.

The village of Mount Carmel, named for Mount Carmel in Palestine, and originally called Winsor, was founded (1864) by a band of adventurous pioneers under the leadership of Priddy Meeks, who made temporary homes in dugouts, began at once to prepare the "bottom lands" for irrigation farming, and to select herd grounds on the adjoining high lands. Because of Indian troubles the site was vacated (1866), then reoccupied by immigrants from the Muddy River settlements in Nevada. As additional families arrived, land outside the village was reclaimed and ranches established along Meadow Creek, Muddy Creek, and Yellow Jacket Wash, on the plateau about Clear Creek Mountain, and in Parunuweap Canyon. The stake-clerk records show that grasshoppers destroyed the wheat in 1871, that part of the fields were destroyed by floods in 1885, and that in 1894 "50 per cent of the stock was lost on account of drought." The most dramatic events in the life of the village was the exodus (1875) of more than half the population to a site three miles up the Parunuweap River—the present Orderville. Thus "Mount Carmel is the father of Orderville."

Glendale, like Mount Carmel, was founded in the spring of 1864 by Mormon colonists, most of them "called" from Nevada. As the group included several families named Berry they called their settlement Berryville. During the first year good crops of potatoes, wheat, and corn demonstrated the fertility of the soil and the practicability of inexpensive irrigation. Favorable reports attracted many more immigrants, but the new town was too isolated for safe residence. To the south the villages on the lower Virgin were about 80 miles distant and reached by roundabout, difficult roads. To the north, the nearest settlements were equally distant, and in winter the roads to them were blocked by snow. To the east and west the village was walled in by cliffs beyond which nobody lived. For protection from the Indians a

stockade inclosing two acres and with accommodations for 25 families was built. In this the Berryville pioneers, also some from Mount Carmel, lived during the winter of 1865–66 and in fear of molestation by the Navajos the entire population left in June, 1866. On returning to their homes in 1871, the original farmers and stockmen were accompanied by many others including Bishop James Leithead, who renamed the village Glendale after his birthplace in Scotland. In 1873 the population was 160; in 1880, 338, or about that for later years. Significant events in the history of Glendale are the building of a flour mill in 1872, the only one in Kane County; the crop loss of 1873, when "the sun was darkened by clouds of grasshoppers"; the drought of 1894; the opening of coal mines in 1891; and the construction of modern approach roads (1930–35).

Soon after the founding of Glendale some of the pioneer families moved into the upper Long Valley, north of the Lava Narrows, where small areas of highly fertile land, abundant water, and excellent natural forage were available for dairy cattle. Their social and religious activities centered at Graham (Ranch Post Office, 1874–1912), chosen as a homestead by Graham D. McDonald in 1865 (?), then abandoned and resettled in 1872 by six families whose descendants cultivate farms at the mouth of Graham, Le Vanger, and adjoining washes and utilize the meadow lands for pasture.

Orderville, the youngest village in the Parunuweap Valley, was founded under unique conditions; the factors that controlled the selection of its site were religious rather than geographic. The soil, water, natural forage, and fuel supply presented no special advantages, and the thinly scattered farmers had easy access to the stores, church, and schools at nearby Mount Carmel and Glendale. The new village was founded to make effective the provisions of the United Order—a scheme designed by leaders of the Mormon Church "to call forth a perfect submission in respect to our temporal affairs equal to that in which we now yield in spiritual matters." All members of the Order were required to deed over their real and personal property to the Board of Management, who had authority to direct all community activities.

The history of the United Order in Long Valley begins with the organization of the Mount Carmel Branch, March 20, 1874, with a membership of 109. Owing to the vigorous opposition of those who disapproved of cooperative labor and thus "made life in the village unpleasant," the enthusiastic initiates sold their lands, moved three miles upstream, and began the building of Order City (Orderville) exclusively for members of the society (February 1875). The first building erected in the new town was a dining room, where for five years all ate in common. To make the community as self-contained as practicable and to provide for expansion, a sawmill, a tannery, and a woolen factory were built; hats, shoes, and soap were made at home, farm lands outside the village were purchased; and ownership of the surrounding grazing areas was assumed with little friction. Orderville seems to have faithfully conformed to the original regulations of the Order for seven years (1875–1882) and to the revised regulations for three years, beyond which time disintegration was rapid. By 1890 cooperative activities had practically ceased, though the Order was not officially dissolved until 1900. Most residents of present-day Orderville belong to the families of the founders and are engaged in the activities that characterized the village 50

years ago. Many of them are "horseback farmers" who share in the cultivation of some 1,800 acres of irrigated land in Long Valley and care for their sheep and cattle on nearby ranges and on the mesa lands south of Parunuweap Canyon.

KANAB VALLEY

The scouts of the Mormon Church who during the decade 1850–1860 investigated the potential resources of the Virgin and Ash Creek Valleys and the borders of the Markagunt Plateau seem not to have extended their systematic search eastward beyond Parunuweap Valley, and during the years 1860–1865 those who visited the region drained by the Kanab and Johnson Creeks speak enthusiastically of "herd grounds" but say little about lands suitable for farm and orchards. To a considerable degree these early observations have proven to be valid. Of the villages in Kanab Valley, Alton for many years served as headquarters for ranchmen; agriculture was a later development. At Kanab and Fredonia stockraising has always been the chief industry; the efforts to develop irrigation farming about these settlements have been discouraging and costly. Of the several farms along the Kanab Creek between Kanab and Alton all but one have been abandoned.

Alton is one of the few Utah villages that developed directly from a cattle ranch. On a scouting trip in 1865, Byron S. Roundy and his brothers, Jared and Lawrence, found the meadow lands and adjoining benches at the head of Kanab Creek "well-watered," "easily cultivated," "tall grass thick enough to be mowed for hay." In 1872 the site was chosen as a summer range by the Canaan Cooperative Stock Company, whose field of operation included much of southwestern Utah. In 1873–74 some 10 families had taken up farms along the Kanab and in nearby Sink Valley, and during the next 10 years a scattered community named Upper Kanab reached its maximum population, reported as "about 200." As a center for stockmen the settlement was well placed; abundant pasturage of excellent quality was close at hand and farm crops produced high yields. But the area between the canyon walls possible to irrigate with inexpensive ditches was small, and suitable dam sites were lacking. To provide "better homes for our children" and "space for school house and church," the residents of Upper Kanab in 1908 selected the present Alton as a site where a compact village could be built and some of the ranch lands converted into farm lands by the construction of a high level ditch. The next year the community was organized as Alton—named for Alton Fiord, Norway.

Kanab received its first inhabitant in 1863 when Levi Savage came to "the big valley east of Pipe Springs" to graze a small flock of sheep. In 1864 he built a cabin and decided to remain. In 1865, 15 families came to share the new site "where the bottom lands, the hills, and surrounding country were carpeted with grass and wild game abounded plentifully," and "where springs and a permanent stream" provided water for irrigation. For the following two years the settlement was abandoned in fear of Indian raids. To maintain this desirable but isolated station a stockade, 112 feet square, was constructed (1867–68), and with this protection available many of the original settlers returned and reoccupied their homes. In 1870, 10 families were living in the "fort," and during that year a town site one mile square was laid out and named Kanab (a Piute word meaning willows).

Bishop A. Milton Musser reports (Deseret News, September 10, 1870):

"To-day the President located a town site a few hundred rods north east of this Fort, on a rise of ground, out of the range of the canyon winds which come down every night. Azra E. Hinckley located several points on the new site where water can be found by digging wells. . . . The corn looks well here, melons and vegetables all plentiful, and it is believed that much grain can be raised in these small valleys without irrigation. There are now sixty whites and one hundred Indians here. The former are under the direction of Bishop Levi Stewart, the latter go and come at the bidding of Elder J. Hamblin. The Indians render material help to the whites in the cultivation of the soil."

Within ten years after it had been made safe for residence Kanab had a population of nearly 400. The slow growth for the next 30 years has been followed by more rapid expansion into the present prosperous village of about 1,400 inhabitants.

Few if any other Utah communities have experienced such discouragement in providing the all-essential water for irrigation. The chief reliance was necessarily on Kanab Creek, the only perennial stream that continues beyond the Vermilion Cliffs. Though water from this source was insufficient for large-scale agriculture, it was easily led to irrigation canals until July 1883, when during the "great washout" the creek bed was sunk 40 to 50 feet below the intake of irrigation ditches, and the walls became dry through under-seepage. Many dams were built, one of them 60 feet high, only to be destroyed by repeated floods and the flumes left useless. During some years no water reached the fields. A skillfully designed dam built in 1890 lasted until 1909, when it was destroyed by a flood even more disastrous than that of 1883. By the ingenious use of rock tunnels for flumes and spillways and vigilant attention to repairs, the present dam, built in 1910–11, seems to have been given a reasonably long life. But the dam makes available only five second feet of water for 1,800 acres of land—a smaller amount to the acre than in any other irrigated district in Utah. Water for household use also has been difficult to obtain. In the early days a little cane

TABLE V

SAN JUAN COUNTY

Settlement	*1882*	*1890*	*1900*	*1910*	*1920*	*1930*	*1940*
Blanding (1904)[1]				385	1022	1101	1438
Bluff (1880)	225	190	315[2]	160	150	200 *?*	284
Carlisle (1889)			28	22	36 *?*		15
Cedar Point (1915)					54	59	173
Indian Creek (1888 *?*)			53	26	6	7	0
La Sal (1878 *?*)			97	39	287	211	285
Lockerby (1916)					187	114	200 *?*
Mexican Hat / Goodridge (1910)				48	10	15	10
Monticello (1887)[3]		115	180	375	768	763	868
Ucolo (1917 *?*)							224
Verdure (1894)			16				12
Indians		[4]				1200 *?*	1443
COUNTY	225	365	1023	2372	3379	3496	4712

[1] Organized as Grayson (1904); name of post office changed to Blanding in 1915.
[2] Includes about 150 prospectors.
[3] Original settlement called Hammond; name of post office changed in 1890.
[4] Indians on the Navajo Reservation not segregated for the period 1890–1920.

from a spring in nearby Toms Canyon, some of inferior quality from wells, but more of it from settling basins supplied by ditches from Kanab Creek. In 1909–10 a pipeline was built to a spring in Hog Canyon, and when this source proved inadequate, water was piped from spring-fed lakes in Cave Lakes Canyon, seven miles distant. Kanab is essentially a home ranch for stockmen, whose range comprises the famous House Rock Valley, the Kaibab, Kanab, and Uinkaret Plateaus, and lands extending northward to the Pink Cliffs. In the southern tier of Utah counties the village for 50 years has stood first as a livestock center.

Fredonia is the "new town" in Kanab Valley—established in 1886, many years after more favorable places in southwestern Utah had been occupied. Like Orderville and Short Creek, in fact like the State of Utah, its site was chosen in response to religious convictions and with little regard to geographic features. The village is said to owe its founding to the attempts by Federal authorities to enforce the laws against polygamy in Utah. To escape prosecution polygamous men of Kanab and neighboring settlements retained one wife at home and provided establishments for the others just south of the State line where they were legally beyond the reach of Utah officials and separated from Arizona officials by the canyons of the Colorado. The episode is recorded in the name bestowed by Apostle Erastus Snow—Fredonia, derived from free dona (free women). Fredonia has no natural advantages. The water obtainable for irrigation of alfalfa, sorghum, and garden crops is inconsiderable; water for household use must come from distant sources; and as a ranch headquarters the village overlaps the interests of neighboring settlements. In a sense it is a suburb of Kanab and for some time received its entire support from that village. Of late years Fredonia, like Kanab, has benefited somewhat by its location—a supply point at the beginning of the 300-mile road across the Colorado River, to Flagstaff.

JOHNSON VALLEY

Johnson Valley, like Kanab Valley, attracted settlers interested primarily in stockraising. Especially along Skutumpah Creek and the branches of Johnson Creek that rise at the rim of the Paunsaugunt Plateau, the grazing grounds were excellent and small plots of well-watered bottom lands provided favorable home sites. As early as 1870 Skutumpah was chosen as a ranch site and in 1875 its population was listed as about 35, a number that included the occupants of nearby irrigated farms. In 1879 the lands and buildings of the pioneer settlers came into the possession of the Kanab Cattle Company. Since that date its ownership has changed many times. At present it is a successful small ranch of irrigated grain fields and adjoining pasture lands.

The development of Johnson Valley below Skutumpah began with the founding of Johnson (1871) as a community center for five families who recognized that water from Johnson Creek was sufficient for the irrigation of several small areas; that springs supplied abundant water for homes and gardens; and that pasturage on the adjoining lands was ample. Within 10 years the new site became an attractive village of more than 100 people living in brick and adobe houses surrounded by prolific orchards and gardens. After 40 years of prosperity the village experienced the disaster common to neighboring settlements: Johnson Creek and its tributaries began to cut deeply into their alluvial floors, destroying fields and greatly increasing the difficulty of main-

TABLE VI

NORTHERN MOHAVE AND COCONINO COUNTIES, ARIZONA, IN "ARIZONA STRIP"

Settlements	*1860*	*1870*	*1880*	*1890*	*1900*	*1910*	*1920*	*1930*	*1940*
Cane Beds (1914)	..	....	....	....	....	5[1]	42	40	17
Fredonia (1886)	..	....	....	96[2]	178	175	210	254	212
Canaan (1868)	..	16 ?	14	....	....	8	....	....	4
Lees Ferry (1869)	..	8	....	....	....	35	5	5	0
Moccasin (1864)	..	[3]	....	....	....	.....	....	78	77
Pipe Springs (1863)	30	55[4]	20[5]	16[6]	15	10 ?	6	....	0
Short Creek (1862)	..	....	....	....	....	.....	36	61[6]	175

[1] First permanent settlers arrived in 1914; previous to that time, site used intermittently as headquarters for cattle companies.
[2] Church census records 216 in 1895.
[3] Reported as 10 families in 1870–1890 and 13 families in 1890–1910.
[4] Includes about 40 men engaged in building "Winsor Castle."
[5] Exclusive of cattlemen and about 50 polygamous Mormons who temporarily moved into Arizona to escape prosecution by Federal officers in Utah.
[6] In 1931 and continuing into 1935 population increased by 10 families (114 persons) representatives of a Mormon sect that practiced polygamy.

taining irrigation ditches. Farming became speculative. At present Johnson is a ghost agricultural town. Its church, school house, and stores are in ruins and the few remaining farms are occupied only during the summer. For nearly 50 years Johnson was a much used stop-over and supply point on the road from Kanab and settlements in Arizona to Panguitch and Salt Lake City. Since the construction of the Kanab-Mount Carmel link in the Utah-Arizona highway (1918) the abandoned village is isolated on a by-pass.

SEVIER VALLEY

The pioneer agriculturists of southern Utah seem to have been concerned almost wholly with the development of the lands west of the Hurricane Cliffs, especially the "warm lands" where cotton might be grown. No systematic attempt was made to colonize the higher, colder Sevier Valley for ten years after John D. Lee (1852) had called attention to the fertile lands near the mouths of the big streams that flowed down the east slope of the Markagunt Plateau: Panguitch, Mammoth, and Asay Creeks. In 1864 six families from Parowan and Beaver who crossed the plateau and camped near the mouth of Panguitch Creek were delighted to find a region with abundant water for irrigation and large areas of meadow land suitable for farming. They decided to remain. They established the town of Fairview—the present Panguitch—constructed an irrigation ditch, and planted a small crop. During the winter of 1864–65, when snow blocked the trails to Parowan (25 miles to the west), the isolated community was forced to subsist on boiled grain and flour ground in coffee mills. Fear of the marauding Utes made it necessary to live within a stockade and forced the abandonment of the village in 1866. In March 1871, the site was reoccupied and since that time Panguitch has experienced uninterrupted growth. Its population has increased from 664 (1880) to 1,975 (1940), its irrigated lands from 300 (?) to approximately 3,800 acres. Its large livestock industry gives it a prominent place among Utah villages and as a commercial center it serves a larger area than any other village in southern Utah. Of late years Panguitch has assumed increased importance as a supply point on the Utah-Arizona highway and as the

gateway to Bryce Canyon National Park.

With the founding of Panguitch began the search for suitable farm lands farther up Sevier Valley, where water from the South Fork of the Sevier River and its tributaries was available for irrigation. In the summer of 1871, 15 families, under the leadership of G. D. Wilson, founded Hillsdale, on the river terrace about half a mile east of the present village. In 1872 the town of Aaron, near the mouth of Asay Creek, was established with an initial population of ten families, 70 people. During the same year farmers occupied land at the mouth of Mammoth Creek, and soon afterward selected homes in Hillsdale, Procter, Johnson, Mammoth, Castle, and other canyons tributary to the Sevier River. In 1880 the families at Aaron joined with those scattered along the river in founding Hatchtown, a village of about 100 people, at the junction of the Mammoth and the Sevier. The location, however, proved to be unsuitable for "keeping water in the ditches," and after the town had been flooded by the breaking of the source reservoir, it was moved to its present site (Hatch) in 1900–02. Likewise north and east of Panguitch farmers established homes in Red, Casto, Limekiln, and Sanford Canyons and at places on the wide meadows along the Sevier. A group of farm houses about 10 miles north of Panguitch constitutes the village of Spry, originally called Orton, which in 1900 enrolled 161 persons, reduced to 87 in 1940.

Soon after Panguitch and other settlements along the South Fork of the Sevier River had become centers for farms, dairies, and ranches the stockraising possibilities of the East Fork Valley, of the Sevier and Paunsaugunt Plateaus, and the more distant Aquarius Plateau, were investigated. As early as 1873 the floor of Grass Valley, the meadow lands above Kingston Gorge, and the adjoining well-watered highlands provided forage for the "Kanarra Coöperative herd." In 1875 the district was chosen as a ranch by cattlemen from Beaver, Utah, who brought with them "4,000 head of cattle and 300 horses." In 1877 Marion Ward (post office, Coyote), enrolled 33 families. In 1880 the discovery of antimony (stibnite) in Coyote Canyon attracted attention to the isolated settlement. During the boom periods of 1880–83, 1906–07, and 1916–17, "about 200 people were employed at the mines, mills, and smelters," and in recognition of the mining interests the town site was renamed Antimony (1921). Except for the erratic incursions of these "outsiders," the population of the village increased gradually from about 200 (1880) to 328 (1940). Because they constitute a continuous strip, and water for their irrigation comes from the same sources, the arable lands between Black and Kingston Canyons of the East Fork of the Sevier are governed as a single unit, thus avoiding conflicts of interest and control. Antimony, therefore, is one of the largest town sites in Utah. As incorporated in 1934 it comprises an area 15 miles long and five to seven miles wide, within which about 2,000 acres are irrigated, chiefly by water from Antimony Creek.

Unlike the continuously prosperous Antimony, Widtsoe and Henderson—the two other settlements along the East Fork of the Sevier—have experienced both prosperity and disaster. In 1876 Widtsoe, at the mouth of the tributary Sweetwater Creek, was the site of a ranch, and in 1902 the permanent home of three families. Anticipating a considerable population supported by farms on the broad Sevier Valley and by grazing lands on the nearby Aquarius and Sevier Plateaus, the original homestead

of 40 acres was divided into lots and named Winder (1910). In 1912 the town site was enlarged and in 1915 its name changed to Widtsoe. The records show that in 1916 the town had a large social hall, two hotels, four stores, and a three-room school house, and a water system that supplied each home. Most of the residents, recorded as 310, cultivated dry farms or small irrigated tracts. "There are 5,000 acres of cleared land and every square mile of the valley has good soil."

For agriculture, the advantages of the East Fork Valley above Black Canyon are large areas of fertile soil in position easy to cultivate. The disadvantages are inadequate rainfall (about 11 inches), high altitude (7,000 feet) and consequent short growing season, and the scarcity of surface water available for irrigation. Though recognizing that the East Fork Valley was unsuitable for large scale irrigation farming, the settlers thought that dry farming supplemented by stockraising would provide a satisfactory living. Beginning about 1880 and for the following 20 years, farms in small numbers were taken up in the most promising places and, lured by the supposed opportunities of the Enlarged Homestead Act of 1909 and by the high prices for produce, more settlers came in 1911, 1912, 1913, and, as a whole, the decade 1910–1920 was a period of expansion. The population increased during the "good years"—1919–1922—and rapidly decreased during the "years of no crop"—1923–1926. At the time when the future of the valley was most rosy the village of Henderson was founded and attained a population of 81. In 1926, the ambitious plans for the rehabilitation and development of the valley began to take shape. Under the leadership of W. E. Holt, who to a large degree financed the project, attempts were made to make all the water of the region available for a common community use. The individual water rights were purchased, including that to 5,500 acre feet of water in Pine Lake hitherto carried by ditch to Cannonville. Dams were built, ditches dug, buildings and corrals erected, and a grist mill and creamery was built at Osiris. Newspapers report that "people rushed in," "fields were plowed and buildings constructed by the score." One estimate gives the population as 1,205 and another as "about 1,000," but many prospective settlers made short stops and the maximum population outside of Widtsoe probably did not exceed 300.

The high hopes for the development of the valley soon faded. Experience showed that the amount of available surface water had been grossly overestimated, that the rainfall was markedly unreliable and generally lacking during the growing season, that frost might come any month of the year, and that the forage was insufficient for intensive grazing. It is reported by the Agricultural Adjustment Administration that in 1935 "44 families were living in a district where seven families could gain a living by farming." Expensive detailed investigation by six different Federal bureaus showed the valley to be unsuitable for agriculture of any kind, and the Department of Agriculture recommended that the land be purchased by the government and the stranded settlers removed to more favorable regions. At present Widtsoe is a group of vacant houses, Henderson is marked only by house foundations, and the farms about these ghost agricultural towns are overgrown with weeds. The inhabitants of the valley are four families on ranches at the mouth of Sweetwater, Horse, Birch, and Ranch Creeks, places that have been occupied since the pioneer days. The control of

the abandoned lands has been returned to the Forest Service.

PARIA VALLEY

The Paria Valley, throughout most of its 50 miles course, is a narrow canyon joined by many tributary canyons, most of them mere slots cut into masses of sandstone. Only at three places is its floor broad enough and flat enough to permit profitable cultivation: at Paria, where erosion has widened the valley between cliff walls; in the region about Cannonville, where closely spaced tributaries have broadened the valley floor, and at Lees Ferry where the Paria River emerges from the Vermilion Cliffs.

As a site for a small agricultural community the vicinity of Paria appeared attractive to the pioneers. The Paria River is here crossed by a hogback (East Kaibab monocline), above which the valley floor broadens and below which for a distance of about eight miles the canyon walls stand back from the stream, leaving alluvial flats in a favorable position for irrigation. Grazing lands extend both sides of the stream. In 1865 Dos Carlos Shirtz settled at Rock House, two miles below "the hogback," only to be driven away the following year by Navajos. In 1871 Rock House was relocated by six families. The next year there were 11 families, and the place produced "plenty of corn, sorghum, and garden truck." In 1873 Adairville, farther downstream, was established, and soon became a prosperous community of cattlemen and farmers. But Rock House and Adairville were destined to short lives. In 1874 "trouble with the ditches" caused the 15 families at Rock House to relocate above the hogback, at the present site of Paria, and in 1878 the eight families at Adairville joined in the exodus. For several years the new village of Paria prospered, the field and garden crops returned good yields, and the cattle increased in number and quality. By 1884 the population included 107 resident members of the Mormon Church, in addition to nonresident cattlemen and about 20 Piute men and women who worked intermittently on the basis of half rations. But prosperity came to a sudden end in 1885. Floods in 1883, followed by more floods in the summer of 1884, washed away farmhouses and fields and converted the narrow stream channel into a wash. Except for a few acres protected downstream by rock buttresses all the arable land disappeared. In September of 1884, 48 people remained, and in 1885 the town site was abandoned. Because Paria (pah, water; reah, elk), is situated on the established trail leading to the Ute ford (Crossing of the Fathers) and at the only feasible crossing of lower Paria Canyon, the village was a camp ground for the Piutes and Navajos and probably for the cliff dwellers before them. Hamblin and other Mormon scouts visited this place many times, and it served as field headquarters for expeditions under Powell (1872), Wheeler (1872), and Thompson (1875).

The suitability for settlement of the upper Paria Valley was recognized by James Andrus, the "Indian fighter," in 1866, and by A. H. Thompson of the Powell Survey in 1871, who noted that the region is well watered and has good soil; that firewood, coal, and lumber are near at hand; that extensive tracts for grazing surround it; and that the climate is favorable for field crops and during most years for fruit trees. Doubtless guided by the reports of Andrus and Thompson the pioneer settlers built homes at Clifton, near the junction of Paria River and Henrieville Creek (1874), and during the following ten years four other villages were estab-

lished, all within a radius of about six miles. Of these Cannonville and Henrieville have grown into sizable villages; Clifton, New Clifton (Losee), and Georgetown have been abandoned.

In the early eighties Cannonville, with a population of about 200 was "the metropolis of Paria Valley," the home of prosperous stockmen, who had available for grazing more than 2,000 square miles of unallotted land, and of farmers who cultivated nearby parcels of fertile land watered by ditches from the Paria River. By 1886 the increased population was using about all the land that the available water could irrigate, and the Paria River and many tributary streams began to cut deeply into their floors, replacing fertile fields with a network of canyons walled with sand and gravel. At Henrieville and Cannonville about a third of the arable acreage of 1880 has been destroyed and carried away as streamborne silt. However, north of Cannonville there remained a large area of fertile land beyond the reach of irrigation canals from Paria River—land that was required if the population of 1890 was to be increased or even retained. To forestall future disasters water was diverted from the East Fork of the Sevier River high on the Paunsaugunt Plateau and through a canal nine and three quarter miles long was led over the Pink Cliffs to the barren lands of the upper Paria Valley. After two years of work by men and boys with axes, picks, crowbars, and scrapers, water from this distant source was flowing through the new town site of Tropic and onto the adjacent fields. The life of Tropic, the largest village in the Paria Valley, had abruptly begun. Like the famous Hurricane Ditch, in Washington County, the East Fork Canal (the "Tropic ditch") is a homemade structure, and like Hurricane, Tropic is a man-made oasis.

Along many of the western tributaries to the Paria, where locally the valleys are broad and easily irrigated, farms were cultivated and ranch sites developed during the period 1880–1900. Of these, only the large and prosperous Findley ranch in Meadow Creek Valley is continuously occupied. The former homes in Swallow Park, in Podunk, Bulrush Lick, Willis, Sheep, Kitchen, and other valleys south of the Paunsaugunt Plateau are now abandoned or used occasionally during the grazing season. Isolation makes these otherwise favorable locations unattractive.

ESCALANTE VALLEY

While camped in Potato Valley (at the east base of the Aquarius Plateau) in 1872, Dellenbaugh and Thompson of the Powell exploring expedition "saw Mormons from Panguitch who talked of making a settlement here and advised them to call the place Escalante." The first settlers came in 1875, and in the following years selected a town site near the junction of Pine Creek and the Escalante River—the present village of Escalante. The reports of arable lands, of abundant water for irrigation and power, and of favorable grazing lands that extended far in all directions induced many families to leave the less congenial plateau tops to the west, and come to the new village even though some of them were forced to find shelter under overhanging rocks, in caves dug in banks, and in makeshift wikiups, tents, and shacks. Six years after its founding Escalante enrolled 441 names, and its consistent growth has made the village one of the largest compact settlements in Utah.

The unsatisfactory feature of Escalante's situation is its inaccessibility. The village stands at the base of slopes and cliffs that necessitate a climb of 2,700 feet and a sharp descent to reach

the highway that stretches 52 miles to the railroad at Marysvale. Before the expensive, skillfully planned road was constructed over the Aquarius Plateau and down the East Fork of the Sevier River wagons traveled the rough, roundabout route through Henrieville, Cannonville, and Panguitch, which made the distance to the railroad about 125 miles. Before the railroad was constructed to Marysvale (1900) salable produce, chiefly butter and cheese, was carted to Salt Lake City, 250 miles.

Boulder, at the base of "Boulder Mountain" (northeast Aquarius Plateau), lies in a small, well-irrigated tract that produces grain and alfalfa (three crops a year), and since its settlement as a community ranch in 1889 has been the center of a large prosperous livestock industry that makes use of the forage in the adjacent Powell National Forest. Boulder is the most isolated village in southern Utah: its nearest neighbors are in Escalante and Fremont Valleys, 30 miles away, and the most used road to the railway is 220 miles long. East of the village for 120 miles no one lives.

SAN JUAN VALLEY

Doubtless a few adventurous trappers and prospectors found their way into San Juan Valley during the years 1850–1870, but the topographers of the Hayden Survey in 1874 found no white men in any part of southeastern Utah. The recorded history of San Juan Valley begins with the founding of Bluff City in 1880, in response to a report of Mormon scouts that the county afforded excellent opportunities for irrigation, farming, and stockraising.

The site of the proposed new settlement was peculiarly isolated. To the north across Utah the only white people were a few families at Moab, 110 miles distant; eastward the villages in Colorado were 70 miles away; southward for 160 miles was Indian country; westward the settlement of Escalante was 115 miles distant. The nearest markets and sources of supplies were Albuquerque, 225 miles distant, and Salt Lake City, 350 miles distant. Though the natural neighbors for Bluff were the settlers on the Mancos and the La Plata Rivers, who could be easily reached by inexpensive roads, the leaders of the Church thought it highly desirable that the Saints in the San Juan country should be brought into religious, political, and personal contact with their fellow Saints in Utah rather than with the "Gentiles" in Colorado and New Mexico. To put into effect this desire for close union involved the construction of a road from the high plateaus of central Utah across the Glen Canyon of the Colorado River, the Red Rock and Grand Gulch Plateaus, and Comb and Butler Washes—an almost superhuman task. Building the road as they proceeded, the members of the San Juan Mission reached the mouth of Cottonwood Creek on April 5, 1880, and though their destination was "Fort Montezuma," 18 miles up the San Juan, they could go no farther. The 225 men, women, and children who had survived the continuous hardships for 170 days, were exhausted, and the diminished herds of horses and cattle were "barely able to move." On April 6, 1880, Bluff City was established. By an act of the legislature (February 17, 1880) San Juan County had been organized and the leaders of the mission band appointed as its officers—when as yet it had no inhabitants.

Life at Bluff during the first few years must have been discouraging. Official reports and personal records speak of "continuous trouble with irrigation ditches"; "floods from the Cottonwood covered fields with mud"; as protection from Indians, "women and children

lived in a fort"; "stock had to be herded to prevent stealing"; in the fall of 1880 "about half of the population moved away"; crops for 1880, 1881, 1882 were "very poor." The "great flood" of June 1884 drowned the farm lands above Bluff, destroyed the settlement of Fort Montezuma, and "changed the meadows on Cottonwood Creek into sand flats"; in 1885 more farm land was destroyed; by 1886 "20 miles of farms along the San Juan in 1880 had become at most 700 acres served by one ditch at Bluff." Though the people of dwindling Bluff accepted the decision of the Church that the mission be held in spite of hardships, their experience had proved that farming in the San Juan Country was unprofitable, and, beginning about 1885, stockraising replaced agriculture as the primary industry. The opportunities to supplement summer forage on Elk Ridge and the Abajo Mountains by raising alfalfa and grain on dry farms and fields irrigated by headwater tributaries of the Montezuma attracted settlers from Bluff and from Mancos and led to the organization of the "tough cattle town" of Hammond (now Monticello) in 1887, Carlisle in 1889, and Verdure in 1894, and to the starting of ranches in Strawberry Creek (Mormon Pasture), Cottonwood Canyon, and Indian Creek. The village of La Sal was at first the headquarters of the Pittsburg Cattle Company (1885), which acquired the rights of the few pioneer farmers.

Three ephemeral events have interrupted the normal development of settlement in San Juan County: the "gold excitement" on the San Juan (1890–92); the "mining boom" in the Abajo Mountains (1892–93); and the "oil boom" at Mexican Hat, which reached its height between 1907 and 1910. The unverified report that rich placer gravel "was strewn all along San Juan Canyon" brought "about 2,000 people through Bluff in 1892," and the shift of the disillusioned miners to stream bottoms and ledges of the Abajo Mountains still left Bluff as the outfitting point. Diaries record that 40 to 50 miners passed in a day; Bluff was amazingly prosperous.

Monticello, still primarily a "cattle and sheep town," has developed into a prosperous village of 886 inhabitants — largely as a result of natural increase. About it are 1,200 acres of irrigated land, watered by streams from the Abajo Mountains, and large areas adapted to dry farming lie to the east and north. East of Monticello, at Cedar Point, and on the Sage Plain at Lockerby, Ucolo, Urado, and a few other places, settlers have taken up land in the hope of success from dry farming.

The last important shift in population of the San Juan Valley came with the establishment of Blanding (formerly Grayson). Like Hurricane in Washington County, and Tropic in Garfield County, Blanding stands on an artificially made oasis developed by the persistent efforts of a small group of pioneers whose farms at Bluff had been destroyed by floods. When the first irrigation ditch was dug (1903), the site of Blanding was a waterless expanse of sagebrush, pinyon, and bare rock. From the few families who established the village in 1904 the population has increased to more than 1,400, and thus makes Blanding the largest settlement in San Juan County and, except for Panguitch, the largest in the adjoining Kane, Garfield, and Grand Counties. In addition to extensive grazing districts the village derives support from an estimated 7,000 acres of irrigated and partly irrigated land and from about 4,000 acres suitable for dry farming.

Mexican Hat, the newest town in the San Juan Valley, has a history unusual

for Utah settlements. It lies in a rough, arid region where the soil is infertile and the water, except the muddy liquid in the San Juan River, is undrinkable. Its attraction has been exclusively placer gold and oil. During the "gold excitement [1892–93] as many as 1,000 prospectors" visited the Mexican Hat region and a few continued their search for precious metals until 1901. The discovery of oil (1882) and especially the drilling of a successful "gusher" (1907), again attracted "outsiders." During the "oil boom" (1908–1911), the population varied from 50 to more than 300 and, on the assumption that the new-found oil field would continue to be productive, the town sites of Mexican Hat and Goodridge were laid out, stores and boarding houses were built, and plans were made for the installation of a water system. But, like the search for gold, the drilling of oil wells soon proved unprofitable. In 1930 Mexican Hat was abandoned and its name transferred to the former Goodridge, where three families operate a store and care for the needs of tourists.

BASE OF THE VERMILION CLIFFS—ARIZONA

Organized scouting (1852–1856) of the "Arizona Strip"—that part of Arizona between the Vermilion Cliffs and Colorado River—revealed a vast grazing district but no large areas suitable for agriculture. Except during floods the stream beds are dry or carry little water and along their banks of crumbling sand the cost of maintaining irrigation ditches is almost prohibitive. The value of the region lies chiefly in springs that emerge from lofty cliffs in canyons tributary to Little Creek and Short Creek; sources from which water may be piped to corrals and reservoirs for the use of cattle and to small fields where vegetable and forage crops may be grown. Springs of moderate flow determine the location of Canaan, Short Creek, and Cane Beds and large springs made possible the settlement of Pipe Springs and Moccasin. Though in Arizona, these settlements were founded by immigrants from Utah and their development has been guided by the Church of Latter Day Saints. As early as 1859 the canyon and adjoining flat lands known to the Piutes as Sobinoquint (cottonwood) and renamed Short Creek Valley, was granted by the Church to William Hyde as a "herd ground." In the winter of 1866–67 W. B. Maxwell built a house at the spring which rises near the mouth of the canyon, and in 1868 Canaan also Cane Beds (Piute, Atitonquint: sandy creek) were chosen as ranch headquarters. Except for a few years after 1866, when four men and one woman were killed by marauding Navajos and Piutes and the isolated families sought safety in the villages of Virgin River Valley, these sites have been continuously occupied by one or more farmers and ofttimes by many stockmen and have generally been developed into profitable ranches. During the period 1900–14, the "great cattle days," 10,000 to 20,000 cattle were mustered at fall and spring roundups at Pipe Springs and Canaan, and cattle on the "Arizona Strip" owned by Maxwell and the Grand Canyon Cattle Company are reported as "more than 100,000." Following the rapid decline of the cattle industry from its peak, about 1908, some progress has been made in converting the old ranch sites into typical southern Utah farms—small plots of ground watered by irrigation ditches and wells, supplemented by nearby range land on which a few cattle and sheep find forage. At the present time farm produce and stock provide ample support for one family at Canaan, two families at Pipe Wash, and about

seven at Cane Beds. At Short Creek the first permanent settler (1914) installed an irrigation system adequate for watering about 200 acres and thus supplying the needs of six to eight families. In 1930 five families were harvesting garden and field crops. During the period 1931–35 the influx of some 10 indigent families, one of them with 40 children, brought the population to 310 (?) and thus far overtaxed the local resources. These newcomers, the first of them from far-off Lees Ferry, were Mormons seeking an isolated place where unmolested they could continue the practice of polygamy which had been outlawed by the Federal Government and since 1890 officially discountenanced by the Church of the Latter Day Saints. The leaders of the movement thought of Short Creek settlement as the "First City of the Millenium," "the City of Fair Colors" within which "bliss and glory" were to be attained through "celestial marriage." But material poverty and hardship led to disillusion: about half of the members of the ancient cult moved away; the others, supported in part by their coreligionists in Salt Lake and elsewhere, continue their precarious existence among sand dunes and bare rock.

Pipe Springs is a historic spot. To the Indians it was Matung (the end of a rock ridge, Winsor Point), the junction point of trails from Paruss (Virgin Valley), Uinkaret and Kaibab Plateaus, Pah Rhea (Paria) River, and Owatie (Long Valley—Upper Parunuweap Valley), and thus was a council ground for Piute clans and a camp for raiding Navajos. Mormon scouts first visited the spring in 1856 during the course of exploration of "the country in and around Colorado River." In pioneer fashion they named it in praise of the marksmanship of Gunlock Bill (William Hamblin), who at a distance of 30 paces shot the bottom out of a pipe without breaking its bowl. Attracted by the abundance of pure water in a region of grass lands otherwise arid, James M. Whitmore selected the site as a ranch (1863), living in a dugout roofed with bark and juniper poles. Three years later (January 1866) in an attempt to recover stock stolen from their pasture, Whitmore and his companion, Robert McIntyre, were killed by Indian arrows. The estate of Whitmore became the property of the Mormon Church, whose leaders saw the importance of Pipe Springs as a center for a large cattle industry and a point of strategic value in the colonization of lands in Arizona. In 1865 six families lived at Pipe Springs and cultivated some 50 acres of land. In 1868 Bishop Anson P. Winsor was instructed to build a fort, safeguard the water supply, and develop the surrounding region as a range for cattle belonging to the Church. (Winsor Stock Growing Company.) The well-known Pipe Springs fort, locally dubbed "Winsor Castle," was completed in 1870–71 and after its connection by telegraph wires with Toquerville, Virgin City, and St. George, (1871), was enabled to give prompt warnings of Indian raids and to summon assistance from neighboring settlements.

In the days of Bishop Winsor, Pipe Springs was not only a stronghold and a ranch that sent out cattle to St. George and to Salt Lake City, it was also a factory of butter and cheese—the produce of about 100 cows. At this place the topographic parties of the Powell Survey (1871–72) obtained their beef, mutton, butter, cheese, grain, and vegetables. Bishop Winsor left Pipe Springs in 1875, and soon afterward the holdings passed from the Church to private ownership but continued to be maintained as a ranch until 1923, when the spring and a few acres of adjoining

land were designated by the Federal Government as the Pipe Springs National Monument. The maximum population (1885–90) consisted of Mormon refugees from Utah, who escaped to Arizona, where polygamy laws were not then enforced.

Moccasin, five miles north of Pipe Springs, was chosen for settlement because of the springs of pure water that rise from the sandy floor of a short canyon. Under the name of Pa-it-spick-ine (big, bubbling springs) the Piutes used the site as a hunting ground, probably also for gardens. Other tribes likewise visited the place; a discarded Navajo sandal suggested the name. In 1864 the lands and water rights at Moccasin, claimed by William B. Maxwell, were purchased by Kale Rhodes and Woodruff Alexander, and through successive transfers became the property of the United Order. When the Order was disbanded (1885) the holdings at Moccasin fell to the lot of five Heaton brothers, who occupied the ranch at that time, and later, through purchase, passed to Jonathan Heaton (1893), whose descendants in three generations number 99. In 1936 this patriarchal community comprised 78 individuals, all of Heaton blood. While the springs and farms at Moccasin belonged to the United Order the Indians were encouraged to establish homes nearby and to learn the care of crops and livestock—an experiment that led to the establishment of the Kaibab Reservation (216 square miles) on which some 80 Piutes now do a little farming and care for small herds of cattle.

Lees Ferry, on the Colorado River at the point where Paria River emerges from the Vermilion Cliffs, ranks high among the historic settlements of Arizona and Utah. It was chosen as a home site by John D. Lee (1869 ?) who planted corn, alfalfa, and fruit trees, abundantly watered by ditches from the Paria. This attractive but peculiarly isolated site, 80 miles from the southernmost settlements in Utah, was doubtless thought by its founder to be a refuge from persecution by his fellow participants in the Mountain Meadow massacre (1857). But the seclusion of the spot was soon dispelled by the discovery that it marked the only feasible crossing of the Colorado canyons betwen Needles, California, and Greenriver, Utah. In 1870 Major Powell accompanied by Jacob Hamlin, crossed the Colorado at this point in a crudely constructed punt and in 1873 a boat capable of transporting horses and wagons and equipment was constructed under the supervision of Joseph W. Young "to enable the missionaries appointed for the Colorado Mission to pass without difficulty." The original "Lonely Dell" had become Lees Ferry, an essential station on the route across the Colorado Plateaus. After 59 years of service the ferry and its picturesque approaches have been abandoned. Since 1929 the pack trains, wagons, and automobiles on the Utah-Arizona highway cross the Colorado on the Navajo bridge near the head of Marble Canyon.

THE TOBACCO BELT OF NORTH CAROLINA

Franklin C. Erickson

IN 1939 North Carolina farmers harvested 815,800 acres of tobacco which yielded 821 million pounds enabling North Carolina to maintain its place as the foremost tobacco producing state in the country. Practically the entire crop is of the flue-cured variety so greatly in demand for the blended cigarette industry and the export trade, but a small amount of air-cured tobacco is grown in the western mountainous region.

The characteristics of the several types of tobacco grown in North Carolina result from the combination of climatic conditions, soil, curing methods, and type of seed used. Variations in the climatic elements; temperature, rainfall, humidity, drought, sunshine, hail, etc. affect yield and quality of leaf and also influence the prevalence of tobacco diseases. Usually climatic conditions are sufficiently favorable to assure a successful crop.

Soil condition appears to be a more exacting requirement than climate. There is a definite correlation between soil type and the characteristics of tobacco quality. Tobacco is rather sensitive to wet or poorly drained soils, and is usually grown on sandy or fine sandy soils because of their superior internal drainage. The mineral content of the soil affects the type and quality of tobacco, but in the coarser textured soils this is effectively controlled by the application of prepared fertilizers. There are large acreages of soil in North Carolina which are suitable for tobacco production, though not yet devoted to its cultivation.

Considering the leading position North Carolina now occupies among tobacco producing states it is interesting to note that tobacco culture was first introduced by migration from the neighboring states of Virginia and Tennessee. The first appearance was in the northern piedmont area along the Virginia state boundary. A heavy, dark, air-cured tobacco was produced which enjoyed favor at home and abroad. In 1852 Eli and Elisha Slade, tobacco farmers of Caswell county, experimented by planting tobacco on light, sandy, infertile soils applying a thin dressing of stable manure. The resulting crop was quite different from the usual tobacco of the time. It was lighter in color and weight and when cured over charcoal fires took on a lemon-yellow to golden-orange color. In addition, it developed a distinctive flavor and aroma. These unusual new qualities won it immediate recognition as a new and desirable type. Thus was developed "bright tobacco," the principal type used in the manufacture of cigarettes.

At the same time, tobacco production was of importance in the neighboring states of Kentucky and Tennessee and from that direction another type of tobacco, burley, was introduced into the valley bottoms of the mountainous western part of North Carolina.

In 1866 the total tobacco produced in North Carolina was less than 40 million pounds, most of which was

grown in the piedmont counties bordering Virginia. From this nuclear area tobacco culture spread to the other piedmont counties, to the Fall Zone, and finally to the coastal plain.

Figure 1 shows by decades the expansion of tobacco acreages in North Carolina from 1879 to 1909. By the latter date the rough outline of the present tobacco belt of North Carolina had been fairly well established (Figure 2). There are four areas which are well defined by the distinct types of tobacco they produce. These are known as the Old, New, Border, and Burley belts. In addition, there is a transition belt between the Old and New belts referred to as the Middle belt.

Old-belt tobacco is produced on the loam and sandy loam residual soils of the piedmont which are derived from the underlying granites, gneisses, and slates. The most important tobacco soil types are the Durham, Appling, and Cecil series which are usually underlain by heavy clay sub-soils. The tobacco produced in this area is generally heavy in body and dark in color, although the tobacco grown on different types of soil develop differences in the quality of the leaf because of variations in texture and available plant nutrients.

New-belt tobacco is light in body and color. It is grown on the more sandy and gravelly soils of marine origin in the central coastal plain. The Norfolk series is the most favored by tobacco growers. In general, the Norfolk soils are infertile, lacking many of the necessary chemicals for good growth of high quality tobacco. However, the grower can regulate the required chemical ingredients through the use of applied fertilizers and thus to a great degree control the quality of the tobacco produced.

Between the piedmont and coastal plain regions there is a transition zone where the overlapping of soil types causes the tobacco to share some of the characteristics of both the Old and New belts.

The Border-belt, in the coastal plain of North Carolina, is a northward extension of the South Carolina Tobacco belt. As shown in Figure 1, it was one of the last sections of the state to adopt the cultivation of tobacco on a large scale. The quality of this tobacco and the type of soil on which it is grown are similar to those of the New-belt. The discontinuity between the New

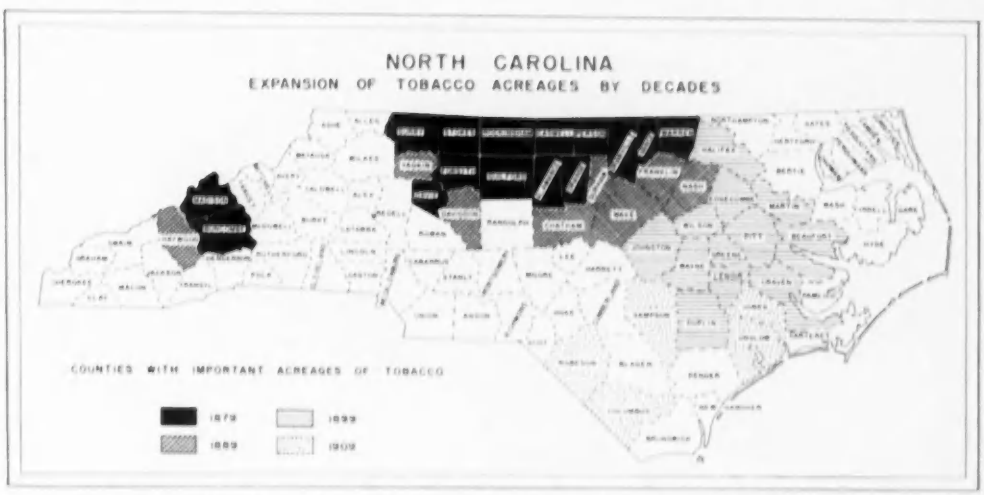

FIGURE 1.—Expansion of Tobacco Averages by Decades—North Carolina.

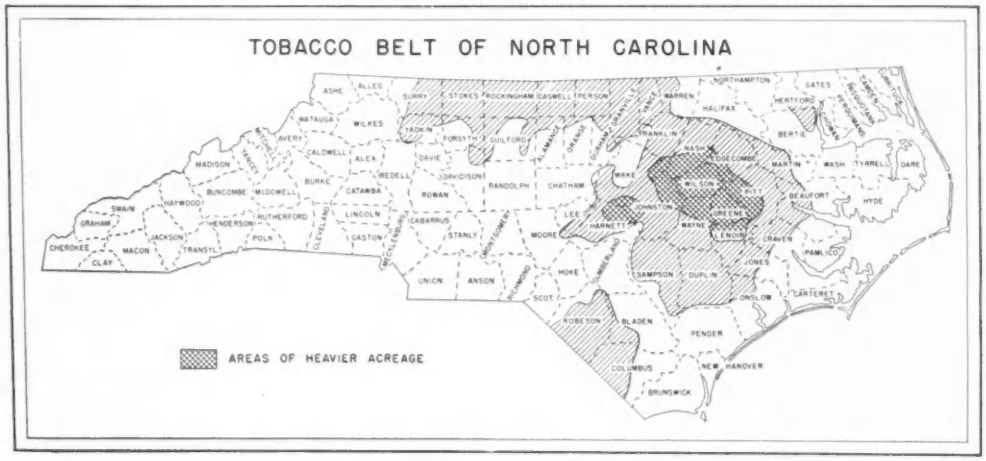

FIGURE 2.—Tobacco Belt of North Carolina.

and Border belts is due to the high percentage of swampland. Bladen county is prevailingly flat with a great number of lakes, bays or pocosins, and slow moving rivers and streams.

Burley, an air-cured tobacco, grown from seed different from that of the tobacco of the other districts, and having qualities different from flue-cured tobacco, is also used for cigarettes, smoking, chewing, and export types. It is grown in small, scattered fields in the valley bottoms of the western part of the state. Figure 1 shows that in the early years Burley tobacco acreage had importance relatively greater than at present, for today only one to two per cent of North Carolina's tobacco crop is of the Burley variety.

Practically all counties of North Carolina report some tobacco production but more than 80 per cent of the total acreage lies within the several belts delineated in Figure 2.

The Old-belt, despite severe soil erosion produces 35 per cent of the state's tobacco crop. Throughout most of the Old-belt 20 per cent of the total cropland is used for tobacco, but the fields are small and fairly well scattered over the farms, usually occupying areas of sandy soils on the uplands.

In the New-belt about 25 per cent of the cropland is employed in tobacco culture producing 52 per cent of the state's total crop. Two areas within the New-belt are of greater importance than the rest. In these areas 50 per cent or more of the cropland is given to tobacco raising. The larger of them centers around Wilson and Greene counties and the smaller includes parts of Wake, Harnett, and Johnston counties. Usually the fields are slightly larger than those of the Old-belt and the yield per acre and price per pound are generally higher.

The Border-belt produces about 12 per cent of North Carolina's tobacco. Much of the land in this section is characterized by large swamps and poorly drained areas. The farms are located on divides where better drainage ensues. Although the farms are larger in size than in other parts of North Carolina and though they possess a greater number of tobacco fields, the tobacco fields are generally no larger in size than those of the other tobacco belts.

In North Carolina, as in other states, the amount of land devoted to tobacco culture is at present governed by law through the Agricultural Adjustment

Act. Previous to the passage of this Act, the amount of land devoted to tobacco culture was governed to some extent by the amount of tobacco in warehouses, the rate of stock depletion, the price of tobacco on the market, and the total world's supply of tobacco. These factors may operate at any time to make adjustments in tobacco acreages whenever deemed feasible.

The amount of leaf used for the manufacture of cigarettes in the United States increased from 166,783,000 pounds in 1919 to 509,133,000 pounds in 1939. Export tobacco dropped from 648,038,000 pounds in 1919 to 342,354,000 pounds in 1939.

Since most of the North Carolina crop is used for both domestic cigarette manufacture and export, the increase in the use of cigarette tobacco aids North Carolina, but the decrease in export has an adverse effect. However, the increase in demand for tobacco in cigarette manufacture is still greater than the decrease in demand for export tobacco; and although the present war has caused a continued decrease in the demand for export tobacco there has been a sharp increase in the manufacture of cigarettes much of which is due to the large numbers of cigarettes supplied to the personnel of the armed forces throughout the several theatres of foreign service. It is possible that this enlarged foreign distribution may cause the taste for American cigarettes and tobacco to encompass the world and greatly increase the demand for our tobacco after the war.

If the demand for greater production arises, North Carolina has large areas in which soil and climate are suitable for tobacco culture, but whether this state will continue to lead the Nation in tobacco production and whether tobacco acreage will increase or decrease in the future is a problem depending on economic and social factors rather than those of physical environment.

THE RAILWAY TERMINAL PROBLEM OF CENTRAL CHICAGO

Harold M. Mayer

THE problem of Chicago's railway terminals, an important public issue for many years, may be nearer to solution now than at any time within the past several decades. Prominent among the proposals for postwar construction in the city is one for a large passenger terminal, and serious study is now being given to a number of alternative sites.

The importance of Chicago as the world's largest railway center, and the long history of its terminal problem, focus the attention of railway men, planners, land economists, and urban geographers in many other cities where similar problems, though perhaps in less intense form, await solution. Geographers can learn much about the structure and evolution of urban centers by a study of the railway problem in central Chicago.

Coördination and consolidation of the railway terminals of a large city is not an isolated problem; it is intimately related to the pattern and the functioning of the entire metropolitan railway network, and, beyond that, to the general regional urban pattern. Changing techniques of transportation as well as the evolution of the patterns of industrial, commercial, and residential land use must be considered in relation to any proposed plan for the rearrangement of railway terminal facilities.

The present Chicago railway terminals were developed as the result of competition among the railway companies to secure the most favorable routes into the city as well as the most centrally located terminal sites. The railways that entered the city earliest used the best routes and sites; those that arrived later were forced to accept less favorable locations or to utilize jointly with earlier lines the routes and terminals already developed. Thus a considerable degree of terminal consolidation and coördination was developed among the railways relatively early.

Nature of the Terminal Facilities

Six major depots located in Chicago's central business district handle the great volume of the railway passenger traffic, relieved only slightly by a number of outlying stations on several of the lines. To the downtown terminals lead all main-line routes. Associated with the depots is a huge agglomeration of subsidiary facilities, including the yards through which the trains are switched in entering and leaving the station tracks, the baggage and express houses, and the mail handling facilities. Beyond that multitude of facilities for the handling of passenger trains and passenger train cars are many of the principal freight houses which required central locations in the horse-and-buggy age and which now suffer from impaired efficiency as the result of traffic congestion on the near-by streets, only partially relieved by Chicago's system of downtown freight tunnels.

The passenger terminals and their associated facilities form a band of steel around the commercial core of

Chicago, and have created barriers that limit the expansion of the urban center. That condition constitutes a large part of the explanation of the unduly high concentration of intensive land uses and high land values in a very small area of central Chicago, a problem of acute importance to all who are concerned with the orderly development and functioning of the city. The band of railways surrounding the narrow peninsula formed by the south branch of the Chicago River on the west, the main stem of the river on the north, and Lake Michigan on the east (Figure 1) came into being during the first decade of railway development in Chicago. It has been strengthened and intensified by each additional railway that added its facilities and traffic to the confused mixture.

The early commercial center of Chicago, along the axis of Lake Street parallel to and one block south of the Chicago River, was the locus that attracted the earliest passenger depots, beginning in 1848. Lake Street was the major retail and commercial street of Chicago until 1869, when the axis of trade shifted to State Street, where it has remained ever since. During the early period of railway development, when the major features of the downtown terminal pattern were in process of formation, each line sought to locate its terminal as close as possible to Lake Street. Even the lines that approached from the south, in order to be as near the business center as possible, pushed their tracks far up the narrow peninsula, thereby occupying the narrow neck of land between river and lake just south of the present business district. That use of the area has, ever since, by interposing a barrier between the business district and the part of the city to the south, constituted a major problem of city planners in Chicago.

LOCATION OF THE PASSENGER TERMINALS

The present locations of the passenger terminals emphasize the ring of steel that confines downtown Chicago.

On the north side of the business district the original eastward extension of Chicago's first railway, at first a passenger and freight line, is now a very important industrial switching route of the Chicago and North Western Railway, serving important loft buildings and factories on the north bank of the river, as well as a number of rail-water terminals. Until the construction of the Michigan Avenue Bridge in 1920, which was partially built on air-rights over the railway, no important commercial development had taken place on the Near North Side. Later, in 1930, the massive Merchandise Mart, largest commercial building in the world, could be located on a sufficiently large site near the business district only by using air-rights over the former yards that had served as the old passenger depot of the Chicago and North Western Railway on the north bank of the river.

On the west side of the central business district, the large and relatively modern passenger terminal of the Chicago and North Western Railway at Madison Street one block west of the river, together with the long station tracks on an elevated embankment, constitutes a wall-like barrier against the westward expansion of the business district. Between that wall and the river to the east are large mercantile buildings; west of it are dilapidated business and residential structures that constitute a portion of Chicago's blighted area.

Three blocks to the south of the Northwestern Depot, on the river bank, is the newest and largest of the pas-

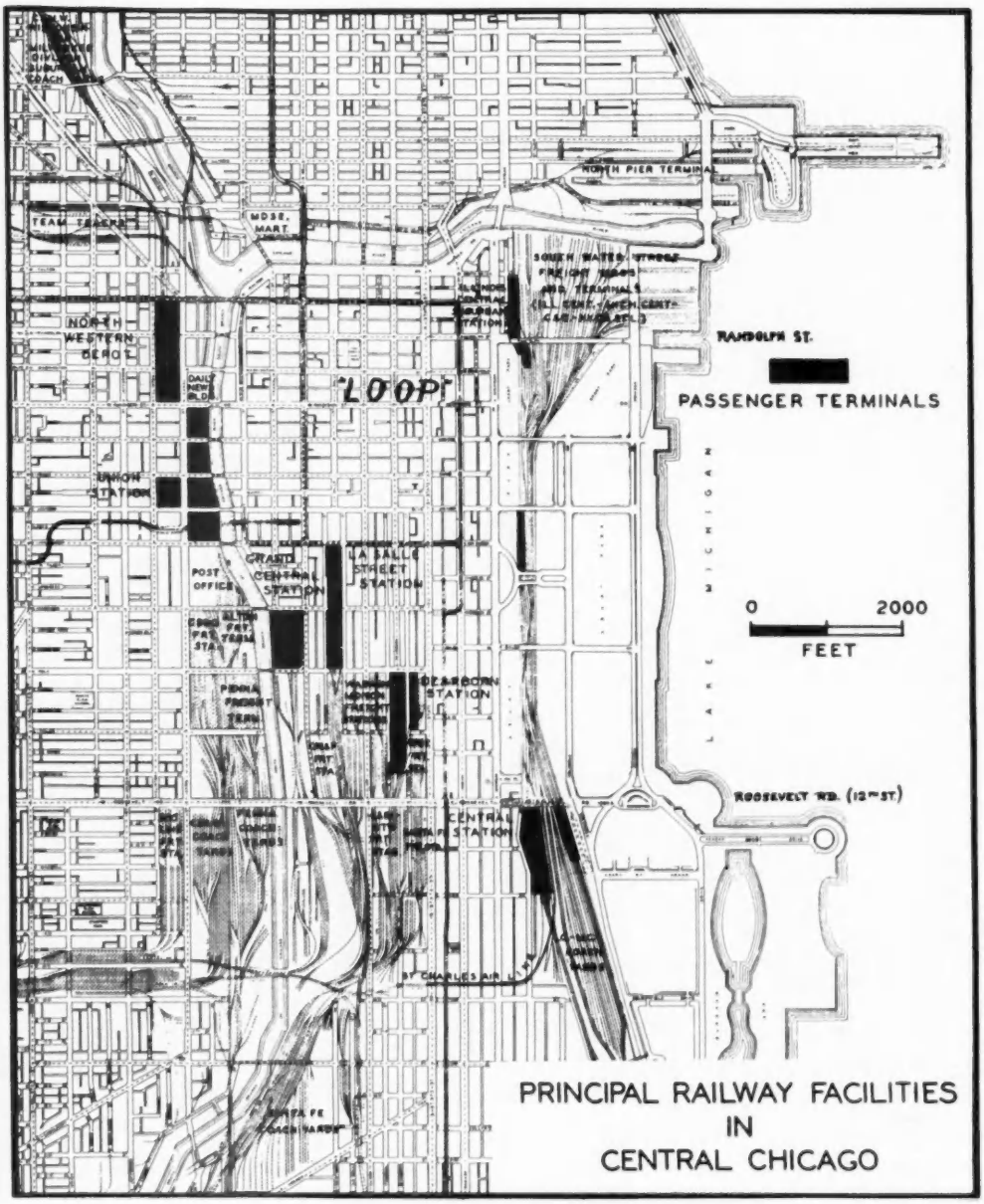

FIGURE 1.—Principal railway facilities in Central Chicago.

senger terminals, the monumental Union Station, which in 1925 replaced an older depot on a near-by site. It serves the Pennsylvania, Burlington, and Alton railroads which approach it from the south, and the Milwaukee Road (C. M. St. P. & P.) the tracks of which enter the station from the north. The latter tracks are close to the river bank and have long been a barrier to westward expansion of the business district. A noteworthy air-rights development, the skyscraper building of the *Chicago Daily News*, occupies a city block over them.

South of the Central Business District, between the lake and the river

across the neck of the peninsula as well as west of the river, the land has been occupied by railways since the first line entered the metropolitan area from its south end in 1852. The railway yards, tracks, and freight and passenger terminals occupy an area on both sides of the river more than a mile in width and well over a mile long. They constitute one of the greatest compact agglomerations of railway facilities to be found anywhere in the world. The tracks leading into the Union Station, and the coach yards and freight stations of the three railways that enter the depot from the south occupy hundreds of acres along the west bank of the Chicago River. East of the river are the vast facilities of the railway that enter three other passenger depots, each at the south end of the "Loop" district. The three depots, namely: (1) the Grand Central Station which serves the Baltimore and Ohio, Soo Line, Pere Marquette, and Chicago Great Western; (2) the La Salle Street Station which furnishes accommodations to the New York Central, the Rock Island, and the Nickel Plate roads; and (3) the Dearborn Station which serves the Santa Fe, Wabash, Chicago and Eastern Illinois, Erie, Monon, Grand Trunk Western, and the suburban trains of the Chicago and Western Indiana, are located on the south edge of Chicago's commercial core. They are all relatively small, and they lack some of the modern devices for the handling of passengers and trains. They are rather old, having been built in 1890, 1903, and 1885, respectively. Along the rights-of-way leading to the depots, which, like the others in Chicago are of the stub type, is a vast assemblage of team tracks, sheds for inbound and outbound freight, mail and express houses, and numerous sidings, extending southward from the depots for more than a mile, and from the Chicago River eastward several hundred yards to State Street.

The eastern side of the business district, and the territory to the southeast of it, is occupied by the right-of-way of the Illinois Central Railroad. South of Monroe Street, which bisects the "Loop" from west to east, the tracks leading into the South Water Street freight yards and stations and into the northern terminal of the electrified suburban line, occupy a wide open cut. There ordinances prevent the erection of permanent structures on the right-of-way, in order to preserve the attractiveness of Grant Park and the lake front. North of Monroe Street, however, the tracks fan out, and north of Randolph Street is a large area of freight stations, tracks, and yards, constituting the South Water Street group of terminals, used by the Illinois Central and its tenant railways. There, too, is the suburban station of the Illinois Central, the only downtown terminal exclusively for suburban trains (Figure 1).

Thus on all sides the central business district of Chicago is bounded by railway facilities. In the confused and disorderly arrangement of the facilities and the congestion of traffic both on the railways and on the streets in the vicinity as well as in the barrier effect of the railways around the business district, lies the essence of the need for terminal consolidation.

DEVELOPMENT OF TERMINAL CONSOLIDATION PLANS

Each of the early railways that reached Chicago, as has been pointed out, sought to operate its own routes into the heart of the city, because at that time as now the industrial and commercial activities were centered there. Furthermore, the transhipment of freight and the transfer of passengers

between rail and water carriers was of vital importance to early Chicago, and each railway sought to construct terminal facilities along the Chicago River and its branches as close as possible to the lake. Only in a few cases, such as those of the Rock Island-Michigan Southern and the Illinois Central-Michigan Central, did two or more of the early railways establish joint rights-of-way into central Chicago. Such instances were the result of either a mutual financial control among the participating railways, or the desire of an eastern and a western railway to establish a connection for direct interchange of through traffic at a point outside the central part of Chicago. In either case, the citizens of early Chicago viewed the arrangements with suspicion, and several attempts were made to discourage such routes, for it was feared that the establishment of traffic routes that by-passed the city would cause the development of competing railway centers.

The decentralization of the city's functions, with the sole exception of the administrative and possibly the wholesale functions, took place after the railway pattern had been established with the concentration of routes at the urban core. The through passenger routes still all converge in the central part of Chicago, and a considerable volume of freight is still handled to and from the downtown freight houses, many of which have functioned at or near their present sites since the earliest days of Chicago's railways. With the completion of the last new route into central Chicago in 1885, however, the period of centralization was brought to a close.

The next period in the development of metropolitan Chicago's railway pattern reached its peak by 1890 with the completion of the major belt lines. The heavy industries, which were responsible for most of the carload freight, quickly took advantage of the opportunity that the belt lines afforded for the development of new sites on the urban periphery. Thus a significant portion of Chicago's freight was eliminated from movement to and through the congested central part of the city. Passenger traffic, however, and a large proportion of the less-than-carload package freight, continues to pass through the terminals within a mile or two of the "Loop."

A third period in the development of the railway pattern began after the turn of the century and gathered momentum with the increased use of the automobile and motor truck. Greater mobility and flexibility in the handling of passengers and less-than-carload freight resulted from the new form of transportation. The new conditions were met by the outward movement of some freight houses, and by the establishment of union freight stations near some of the major outlying industrial concentrations.

Inertia has been an important factor in the continuation of a railway pattern that developed in response to the needs of a city vastly different from the metropolitan Chicago of today. The railway rights-of-way that converged near the central business district became intricately interwoven into the financial structures of scores of railway companies some of which are separate entities now, and others which exist only in law and not in physical fact.

Early Terminal Consolidation Plans.—Scores of plans for the more orderly arrangement of the downtown terminals and for the relief of congestion have been brought forth during the past forty years, but no comprehensive solution to the problem has yet been decided upon. Except for the building

of a few individual facilities, mainly on the sites of earlier facilities that they replaced, the railway pattern in central Chicago today is essentially that of 1885.

The outstanding aspects of the problem were recognized shortly after the turn of the century by Frederic A. Delano, then president of the Wabash Railway. He suggested that six depots be constructed side by side on property already owned by the railways, from State to Canal streets, on Twelfth or Taylor Street, a mile south of the Loop district (Figure 1). In order to make room for those facilities, the Chicago River was to have been straightened, thereby eliminating a wide easterly bend that narrowed the neck of the peninsula upon which the central business district is located.

The Delano plan, however, would have left the terminals unconsolidated, would not have reduced the barrier effect of the railways across the base of the peninsula, and would have produced undesirable street traffic congestion in the vicinity of the proposed terminals.

That the Delano plan received serious consideration is evident from the inclusion of some of its essential features in the monumental Plan of Chicago of Burnham and Bennett. That plan, probably the most comprehensive city plan ever evolved, formed the basis for many of the outstanding public improvements in Chicago from the date of its publication in 1909 to the present.

Burnham and Bennett pointed out the desirability of placing all the passenger terminals either above or below the street level, and suggested that they be arranged to avoid the closing of streets, a declaration of principles fundamental to nearly all of the subsequent plans. The Burnham and Bennett plan proposed two general locations for the future passenger terminals, one along the west bank of the Chicago River's South Branch, and the other along Twelfth Street as suggested by Delano.

Through Routing of Suburban Trains.—The proposals of Delano and of Burnham and Bennett for the location of the passenger terminals along Twelfth Street would have involved considerable difficulty in the handling of passengers to and from the suburban trains because Twelfth Street is a mile or more from the main part of the business district. A partial solution to the problem was suggested in the routing of suburban trains in tunnels between the Twelfth Street depots and the central business district, but that would have been very costly and not entirely satisfactory.

Through routing of suburban trains was suggested by several planners as a possible solution to the difficulty. Trains were to have been routed past the business district to terminals on the opposite side from that from which they came. A train from south of Chicago, for example, would proceed to the business district, discharge its passengers, and continue on the lines of another railway to the north or west sides of the city. That plan, it was pointed out, would enable passengers to travel through from one side of the city to the other without changing trains in the business district, and would eliminate back-up movements of trains between terminals and coach yards. The most serious objection, however, was that the peak traffic loads would never be available in both directions at the same time, and consequently trains inbound to the business district with full loads would usually be nearly empty leaving the central area.

Aside from the proposals for through routing, it was recognized that elaborate and spacious terminals were not required for the suburban traffic, and that if separate terminals were provided neither the suburban terminals nor the

major terminals for long-distance intercity traffic need be as large as if the two services were combined in the same terminals. Most of the terminal consolidation plans after 1909, however, failed to accept the desirability of such functional separation of traffic.

Northwestern Depot.—Two large new depots were constructed in conformance with the Plan of Chicago. Together, they added new important physical elements to the railway pattern of central Chicago which greatly affected the details of all terminal consolidation plans that were brought out subsequently. One of the new depots was already under construction when the Burnham and Bennett Plan of Chicago was published; the other was announced soon after but was not opened until more than a decade later.

The Chicago and North Western Railway, which for nearly sixty years had conducted its passenger operations from Kinzie and Wells streets on the north bank of the Chicago River, completed a large new depot in 1911 at Canal and Madison streets, just west of the central business district. The station was made necessary by increased traffic and by the limited capacity of the former depot, which was located at a place where purchase of additional land for expansion was impossible. Furthermore, in order to reach the old station, trains had to pass over a two-track movable bridge that spanned the north branch of the river, close to the throat of the station yards. In order to eliminate these handicaps, it was decided to construct an entirely new terminal.

The terminal building of the Northwestern Depot is on Madison Street, a half-mile south of the east-west line that led to the old depot. Behind the depot's head-house is a long elevated structure with sixteen station tracks, and six tracks leading into the station from the junction with the old line. It was necessary to relocate and elevate a section of the old line near Kinzie Street, in addition to constructing the lead into the new terminal. The latter created a wall that inhibited expansion of the business district westward.

Union Station.—At about the time that the Northwestern Depot was completed, the Pennsylvania Railroad and the companies associated with it in the old Union Station, then located two blocks south of the new Northwestern Depot, announced plans to construct on a near-by site a monumental new Union Station to replace the old one that had been in continuous service since 1880. The site chosen was, like that of the Northwestern Depot, in conformance with the recommendations of the Plan of Chicago. The tracks were to be depressed along the west bank of the river, east of Canal Street, over which the east-west streets were to be carried on bridges. In order to construct the station at the proposed location, it was necessary that the Pennsylvania Railroad provide a new freight terminal to replace the one that was to be removed from the proposed depot site. The railroad planned a large freight terminal two blocks west of the passenger line, at Van Buren Street between Jefferson and Des Plaines streets. In order to reach this freight terminal site it would have been necessary to construct a double-track elevated line a mile long from the main line at Sixteenth Street. A strip of land a block wide had been purchased to accommodate the proposed new freight line.

When application was made to the City Council for the necessary ordinances to permit the Union Station and freight terminal project to be constructed, serious objections were raised.

It was feared that the new terminal would prejudice future attempts to consolidate all the railway terminals, that the freight line would be unsightly, and that both lines would prevent the opening of through streets westward from the business district. Undoubtedly the wall-like barrier created by the rail approach to the Northwestern Depot was responsible for the objections of many people, who feared that the construction of the new project would create additional barriers of similar type. Particularly objectionable was the proposed freight line, which was subsequently dropped from the plans, although the railroad company had purchased many acres of land for it, between Jefferson and Des Plaines streets. Not until 1942 was the land finally sold for other use.

The necessary ordinance was passed by the City Council on March 23, 1914, enabling construction of the Union Station to begin, but without the freight line. Under the terms of the ordinance, the railroads paid for vacated streets, were required to maintain viaducts in order to carry the street approaches to the Chicago River bridges over the tracks, and were required to widen Canal Street for through vehicular traffic. As a result of the latter provision, the station head-house was constructed in two portions, the portion between Canal Street and the river serving as the train concourse between the two sets of stub-ended tracks, and the portion west of Canal Street serving as the main waiting room, over which an office building was constructed. Passage under the street between the two depot buildings is through a wide pedestrian subway lined with ticket and baggage offices.

Completion of the Union Station was delayed by the first World War, but the terminal was opened in 1925.

The Union Station is Chicago's largest and newest passenger terminal. The double-stub layout consists of 24 tracks with a standing capacity of 332 cars, of which 14 tracks with capacity of 191 cars are at the south end, used by the Pennsylvania, Burlington, and Alton railroads, and 10 tracks for 141 cars are at the north end and are used by the Milwaukee Road. Two through tracks connect the north and south approaches to the station. They are alongside the Chicago River, and pass underneath a parking lot at the east end of the main concourse. These two tracks provide a limited amount of flexibility in operation of the terminal and furnish a through route for mail, baggage, and express cars, freight trains, and occasional special passenger trains. They are particularly important in enabling Milwaukee Road mail cars, which are placed on trains north of the concourse, to be spotted under the post office south of the station, for loading.

In the selection of the site for the Union Station, the participating railways had to consider the approaches from both north and south since the railways were to enter from both directions, as well as the proximity to the central business district and to the mail handling facilities.

Placement of the approach tracks to the Union Station below the level of the streets and the viaduct approaches to the Chicago River bridges, an essential part of the terminal improvement project, permitted the construction of noteworthy buildings on air-rights over the tracks both north and south of the depot. On the north is the large Chicago Daily News Building, constructed over the approach tracks used by the Milwaukee Road.

An extensive rearrangement of coach yard, mail, express, and less-than-carload freight facilities was necessary

along the south approach to the Union Station for two miles.

Most spectacular of the new facilities is the main Chicago Post Office, two blocks south of the station head-house. The building, two city blocks long, is an expansion of an earlier parcel post terminal on the same site, which was incorporated as a part of the larger building. Both are so located that trains placed in the south tracks of the depot for loading of passengers can at the same time receive their mail loads on adjacent platforms. The mail is delivered by chutes directly to the mail and railway post-office cars, which can then be coupled directly to the head-ends of the outgoing trains.

The construction of the Union Station, along with the straightening of the Chicago River which was carried out shortly afterward, necessitated a comprehensive reconstruction of many of the railway facilities in the area south of the depot and west of the Chicago River's south branch. The Union Station project, therefore, involved not only the construction of a new passenger terminal, but also the large-scale rearrangement of many accessory facilities. Although the project resulted in new and modern layout of these facilities, it did not result in any reduction in the amount of land devoted to railroad uses. Furthermore, the multitude of new facilities is fixed, and represents new elements that must be considered in any comprehensive plan for the solution of the railway terminal problem.

Terminal Consolidation Plans, 1912–1915.—The announcement of the plans for the Union Station and the numerous objections that developed to some phases of the proposed project encouraged several investigations of the entire terminal problem of the city. Within the next few years a number of voluminous reports were issued. Although they all agreed on certain general principles, diverse proposals were made for the location and extent of the new facilities that seemed to be required.

Two noteworthy independent large-scale investigations were carried out. One, sponsored by a committee of the City Council, was made by John F. Wallace; the other, sponsored by a citizens' committee organized by the City Club of Chicago, was carried out by Bion J. Arnold, who had recently been active in development of New York City's Grand Central Terminal. Both investigators were charged with the responsibility of reviewing the various terminal proposals that had been made, and either to recommend the adoption of one of them or evolve new and better plans.

Many were the plans that were reviewed. Most of them proposed a reduction in the number of passenger depots, but the plans differed greatly in the proposed locations and layouts of both passenger and freight terminals. They differed also in the amount of railway land that would have been released for other uses.

The Arnold report recommended, in addition to the straightening of the Chicago River, the electrification and placing in subways of all tracks in and near the central business district with the exception of the trackage along the lake front and the facilities that had recently been constructed in connection with the Northwestern Depot.

The Wallace Report advocated the construction of the Union Station and of the Pennsylvania Railroad freight terminal as planned, with the sole exception that a location for the latter was suggested one block south of that proposed by the railroad. In addition, the report reiterated the desirability of ex-

tending through streets west and south of the central business district, of reducing the amount of freight handled in central Chicago, and of eventually consolidating the older passenger terminals. Several alternative schemes were presented, but no specific terminal pattern was advocated.

Meanwhile, the approval by the City Council of the Union Station development and the start of construction on that project introduced a new element into the terminal pattern that partially invalidated many of the plans that had been proposed without regard for the new facilities. A second new element was introduced shortly thereafter in the form of specific commitments for the development of another important feature of the original Plan of Chicago: the improvement of the lake front.

The Lake Front Ordinance.—The improvement of Chicago's lake front, particularly on the South Side, has had important direct effects upon several railways as well as upon the general terminal plans. As the result of their route along the lake shore north of Fifty-first Street, the Illinois Central and Michigan Central have been particularly affected.

In order to develop a park area along the lake shore, the South Park Commission, the municipal body then having control of the area, in 1912 received from the Illinois Central the riparian rights north of Fifty-first Street. In the succeeding years a number of studies and plans were made for the development of the property as a park. The War Department, however, before giving a permit to fill in the land, insisted upon plans for a harbor development south of Twelfth Street. Both park and harbor areas were allocated in the Lake Front Ordinance of 1919, which made possible the present Burnham Park, on the South Side, site of the Century of Progress exposition of 1933–34. Changing requirements of industry have eliminated the necessity for a harbor development at the proposed location.

The Lake Front Ordinance, passed on July 21, 1919, in addition to providing for electrified operation of the trains on the lake front route, provided for a passenger terminal to be erected on the lake front at Twelfth Street east of Michigan Avenue. That development, on the site of the existing depot, was to provide accommodations for the railroads that used the Grand Central, La Salle, and Dearborn stations as well as for the Illinois Central and its tenants. The new depot was to have made possible the consolidation of the terminals south of the central business district. The Illinois Central was prohibited from making any capital improvements on its right-of-way north of Thirty-first Street unless in conformity with the new terminal plan. In return for the obligations it assumed, the Illinois Central was granted a strip of lake front land to permit enlargement of its right-of-way for the new depot.

The Railways' Plans for Individual Terminals.—The Lake Front Ordinance did not result in any immediate construction. Several of the railways that were to use it presented alternative plans for the redevelopment of their own terminals on the land that they had been using since their original entrance into the city. It was obvious that the railways were not to give up the terminal sites that they had secured in the frenzied competition of the preceding century without strongly presenting their case.

The Chicago and Western Indiana and its tenant Dearborn Station roads using the oldest passenger depot in Chicago presented an elaborate plan

for the complete reconstruction of their properties south of the central business district. The plan provided for a new passenger station on Polk Street and extending from State to Clark streets, and a comprehensive scheme for freight terminals immediately to the south to accommodate the several railroads operating freight facilities in the vicinity of Dearborn Station. The principal objection of the city to the presence of railways in the area immediately south of the central business district was overcome in the plans by the incorporation of through north-south streets as integral parts of the design. The plan provided for complete utilization of all the Chicago and Western Indiana property as well as the land now used by its associated railroads for freight stations. The area of land used by railroads would not have been greatly reduced had the scheme been carried out. Publication of the plan indicated the unwillingness of the Western Indiana road and its tenants to participate in the use of the proposed lake front depot, which involved relinquishment of the supposed competitive advantages of an independent terminal close to the commercial core of Chicago.

The owners of the La Salle Street Station, the New York Central and Rock Island systems, following the lead of the Western Indiana in announcing their unwillingness to participate in a joint lake front terminal, indicated that they were developing their own plans for a new terminal on the same site as the La Salle Street Station. Neither the Western Indiana nor the La Salle Street Station plans bore fruit.

The decline in railway traffic during the past two decades, the growing importance of automobile and motor truck in both competing with the railroads and in modifying the requirements of city planning, and the consequent financial difficulties of many railways, prevented any of the terminal plans from being carried out. The new mode of transportation, however, encouraged a further analysis of the terminal requirements, and several reports were issued after 1930. Most important of them were the Noonan and the Boatner reports.

The Noonan Report.—The Noonan Report, published in 1933, differed from most of the earlier reports in proposing the complete elimination of all railways from the area south of the central business district and between the Chicago River's south branch and the lake front route. The advantage of the elimination, the report pointed out, was that expensive viaducts and grade separations would not be necessary in order to open through streets between the business district and the southern part of the city through the area that is occupied by railroads.

Several important changes in the street and land use pattern of downtown Chicago had occurred in the years preceding the Noonan study and greatly influenced its recommendations. In 1920 a major traffic artery was opened between the central business district and the North Side by the completion of the Michigan Avenue Bridge. A similar connection, since built, was planned to link the outer drive along the lake front. A major east-west artery, Wacker Drive, a double-decked street along the Chicago River, passed just to the north of the city's commercial core. Finally, the world's largest commercial building, the Merchandise Mart, was constructed northwest of the central business district. The result of all those improvements was that the "center of gravity" of the business district began to shift northward, and most of the new building construction in the downtown area was along its northern fringe.

It became evident that the Twelfth Street locations for passenger terminals recommended in previous studies were losing much of their former importance.

The Noonan study recommended the construction of a large passenger depot at Randolph Street east of Michigan Avenue, near the northeastern corner of the central business district and just east of the present Illinois Central suburban terminal (Figure 1). That location, the report pointed out, would be conveniently accessible over the new streets and boulevards, would be close to the business center, and would be on land already devoted to railroad use, while eliminating many of the facilities in the railroad areas south of the business district that had been barriers to free intracity circulation. The depot was to be of the stub type, the tracks ending near the south bank of the Chicago River. Freight terminals were to be consolidated in the area west of Clark Street, thereby retiring from railway use the land now devoted to the approaches and freight houses of the Dearborn Station group. The decreased railway traffic of the depression period preceding the Noonan Report pointed to the practicability of a terminal much smaller than those advocated by earlier investigators. The proposed Randolph Street depot was designed with but twenty tracks for long-distance intercity trains. A separate small terminal, an expansion of the present Illinois Central suburban station, was recommended to accommodate the suburban traffic of the railways that would participate in the terminal project.

As an integral part of the development recommended by the Noonan Report, the projection of streets and the development of buildings on air-rights in the area north of Randolph Street and east of Michigan Avenue was urged.

The Boatner Report.—The Federal Coördinator of Transportation, as a part of a comprehensive study of the nation's railway problems during the depression of the early 'thirties, sponsored a study of Chicago's terminals. The report, made by V. V. Boatner, appeared shortly after the Noonan Report. As a prerequisite to its specific recommendations the Boatner Report presented detailed studies of freight and passenger traffic flows and train movements through the Chicago Terminal District.

The basic assumption of the Boatner study was that considerable savings would result if the traffic were concentrated in a limited number of routes and yards, thereby eliminating many of the transfer movements between railways, as well as eliminating some of the facilities with duplicate functions.

The report recommended the pooling and coördination of some passenger terminals as a means of effecting savings in the operation of Chicago's railways and as a means of releasing for other use a portion of the land now occupied by railways south of the central business district. By eliminating the Grand Central and Dearborn stations and retaining the present Northwestern, Union, Central, and La Salle Street stations, savings estimated at more than $600,000 per year in operating expenses could be effected and a considerable reduction in the area of central Chicago used by railways could be brought about, according to the report. No new passenger terminal facilities were recommended, as it was found that the four terminals would be adequate to handle the volume of traffic that existed at the time of the study.

The Boatner Report has been criticized by some because its recommendations were based upon the volume of traffic during 1934, a depression year. Subsequent increases in railway traffic, even before the war, point to the need

for somewhat more extensive facilities than those recommended.

ELEMENTS OF TERMINAL CONSOLIDATION PLANS

Although the many plans brought out during the past forty years for the consolidation, coördination, and rearrangement of Chicago's freight and passenger terminals vary greatly in their specific proposals, a number of common elements may be recognized in all or most of the plans.

Reduction in Land Area Devoted to Railway Use.—Practically all of the plans are predicated upon a reduction in the area of land to be devoted to railway use.

The competition of the railways for the best entrance routes to Chicago and for the best and most advantageous terminal sites has resulted, in many cases, in the provision of many facilities that could be eliminated by pooling of some operations, or could be jointly operated by more than one railway for their mutual advantage, as well as to the advantage of shippers, passengers, and the general public. Considerable areas of land now devoted to parallel rights-of-way and to minor terminal facilities the functions of which could be carried on in a few modern and well located terminals, could be released.

Although the coördinated operation of the freight facilities in the Chicago Terminal District would result in the elimination of some yards and possibly of some routes, the center of interest has always been in the extremely valuable land close to the business district, particularly that land between the Chicago River and Lake Michigan for a mile or two south of the central business district. There is but a narrow strip of land only two short city blocks in width between the Illinois Central's lake front route and the freight stations west of State Street, along which the business district can expand southward. The railways on both sides have had a detrimental effect upon potential development within the strip, and the business district is confined to the north of the railway phalanx. Release of some of that large area, particularly the part used by the Dearborn Station group of railways, would free the business district for southward expansion.

Air-Rights Development.—Many of the later plans call for development of air-rights over the railway tracks as a method of providing additional area for relief of the crowding and congestion of the central business district. The demonstration of the advantages of utilizing air-rights in connection with the Grand Central and Pennsylvania terminal developments in New York City has focused attention upon the possibility of similar developments in Chicago. Conditions in the two cities, however, are fundamentally different. Whereas New York's business districts are confined on a crowded island surrounded by wide water barriers, Chicago's central business district is bordered by a wide area of residential, commercial, and industrial land use, which is badly blighted and depreciated in value. There is no wide barrier to the expansion of Chicago's central business district except Lake Michigan on the east and the railway phalanx on the south. Noteworthy air-rights development, however, has taken place northwest and west of the business district, where the Merchandise Mart and the Chicago Daily News Building, respectively, occupy areas over the railway tracks. As a result of the decentralization of many of the functions of the central business district and the large areas available for expansion of the district, relatively little development of additional air-rights will be required.

Electrification.—Most of the terminal consolidation plans are based upon the assumption that all, or a considerable portion, of the trackage of the participating railways within the terminal district are to be electrified. Air-rights development and the extension of many streets over railway tracks are incorporated in the various terminal plans because it was assumed that electrification would eliminate smoke and gases that would otherwise accumulate.

A comprehensive study of the electrification possibilities of the Chicago railways was made in 1912, primarily in relation to smoke elimination. The report stated that, although complete electrification was technically practicable, it would be financially impossible.

The introduction of new types of motive power, particularly the Diesel-electric locomotive, which is essentially an electric locomotive that carries its own power plant thereby making unnecessary the expensive capital investment in fixed power plants and transmission lines, has greatly reduced the necessity, and even desirability, of railway electrification. The Diesel-electric locomotive, however, due to carbon monoxide fumes, is not suitable for extensive underground use and therefore cannot be associated with large-scale air-rights developments.

The Illinois Central's suburban trackage constitutes the only steam railway electrification in metropolitan Chicago. It was carried out in conformance with the Lake Front Ordinance, and not primarily to increase the railway's operating efficiency or to reduce its costs. In spite of the great increase in passenger traffic that occurred as a result of the electrification, and with the heaviest railway passenger traffic density in the metropolitan area, the earnings from the service are only about one per cent annually on the total investment, not only of the electrification, but of all the facilities used in the service.

Railway electrification is practicable without public subsidy only where such improvement will result in greater efficiency and lower operating costs to the railways. Most railways are unable to finance electrification projects, and their supposed advantages are open to question in view of the newer types of power now available, and the lack of necessity for air-rights development in Chicago.

Extension of Through Streets.—The securing of better communication between the central business district and the other parts of the city, particularly on the South Side, is an essential element of nearly all the terminal plans for Chicago. The multitudinous railway facilities in the phalanx south of the central business district prevent the construction of streets in that direction without expensive viaducts. The straightening of the Chicago River was carried out with the dual objective of permitting a more orderly arrangement of railway facilities in the vicinity and thereby of removing obstructions to through streets. The former river bed is unused, however, and new streets have not as yet been extended through the area.

Recently there has been an increasing realization among city planners that access to and from the central business district is not necessary on every street, but that vehicular traffic other than that engaged in local receipt and delivery can be routed on a limited number of wider streets, or preferably on specially designed "expressways" or limited access routes, grade-separated for the free movement of traffic. Accordingly, the relationships between the pattern of railway terminals and that of the "expressways" are very important. There is now under study a series of "dis-

tributor" highways, the function of which would be to collect and distribute the traffic of the central business district and the industrial belt on its fringes. The distributor arteries are planned to form two quadrangles just outside of the business area and are to be linked with radial "superhighway" routes. The location of the railway terminals in downtown Chicago, both passenger and freight, must be considered in relation to the proposed distributor highways, which can serve as transfer routes between passenger stations and between industries and freight stations, thereby relieving congestion on downtown streets.

CONCLUSION

After forty years of plans for the more logical arrangement of its downtown railway terminals, Chicago still possesses a pattern of railway facilities near its commercial core that arose in response to competitive demands that no longer exist. Railway facilities are among the most inflexible elements of the city pattern. Unlike streets, public buildings, waterfronts, or even private buildings, which are subject to public regulation by zoning, railway facilities, because of the tremendous capital investment they represent, and because of the intricate financial structures that have been erected upon them, are not easily capable of rearrangement by action of public authority. More than new railway terminal plans, Chicago needs the dynamic and inspired leadership that alone can bring together all of the conflicting but not incompatible interests that have in the past impeded the effectuation of the terminal plans.

Chicago's railway terminal problem demonstrates very clearly the close interrelationships among all of the features of the urban complex. Only when each part of the urban organism is so located and so arranged that it can perform its functions in relation to the immediate requirements and not in relation to the requirements of the past, can the city function smoothly and without friction. The rationalization of the city pattern into a smoothly functioning entity is a geographic challenge.